



cirad

AGRICULTURAL RESEARCH
FOR DEVELOPMENT

Annual Report

2015

RESULTS AND
PROSPECTS





A word from Michel Eddi, President of the Board of Trustees

2015 was the year that put climate change centre-stage. Many CIRAD experts were involved, by virtue of the

wealth and diversity of their knowledge, in shedding light on the global debate. Our colleagues, who are particularly well versed in the political objectives of COP21, worked with our scientific partners in the South to conduct an in-depth inventory of the situation, make diagnoses, and come up with solutions to prepare for and adapt farming systems in the South to the expected climate changes. They summed up their work in a book entitled "Climate Change and Agriculture Worldwide", in collaboration with the Agence française pour le développement (AFD). Climate change was the common theme for the year and the focal point focal of our participation in many events with a global audience, either organized by CIRAD or to which it contributed: the Paris International Agricultural Show, with the AFD; then the 3rd Global Science Conference on Climate-Smart Agriculture, in Montpellier; and another conference, "Our Common Future under Climate Change", which brought together more than 2000 scientists from all over the world. And COP21 itself, whose work resulted in the signing of the Paris Agreement. More than twenty of our scientific and management staff members participated, in various ways, in this global event. The agreement signed is the first to see adaptation to climate change in southern countries, whose vulnerability is widely recognized, as a vital issue.

This vast global drive to find solutions forms the backdrop to the "4 per 1000" initiative announced by the French Minister of Agriculture in March. This is major political initiative involving CIRAD, the CGIAR, INRA and the IRD, supported by numerous partner organizations, both international and national in other countries. It has placed a promising bet on putting soil quality back at the heart of agricultural operations, by mitigating the effects of greenhouse gas production by promoting carbon capture in the soil, boosting organic matter

enrichment and soil fertility, and consequently increasing food security by means of a sustainable increase in productivity. This noble, shared political and scientific ambition makes agriculture one of the solutions to be promoted with a view to limiting the impact of climate change, to which we will be giving substance through our work with our partners in the South!

2015 also saw many other events concerning CIRAD, which I quote in no particular order, as proof of their diversity: the death of our founder, Henry-Hervé Bichat; the creation of the IAVFF, which replaces Agreenium, taking over and broadening its mandate and institutional range; the launch of the "PRO-IntensAfrica" initiative, the basis for a long-term partnership between Europe and Africa on the ways of ensuring ecological intensification of farming systems in Africa; the implementation of a five-year plan to structure the life and activities of our platforms in partnership for research and training (dPs); the second stage of our "Impress" methodological approach to characterize and quantify the impact of our activities; the stepping up of our presence in southern Africa and the actions taken to re-establish CIRAD in Ivory Coast long term; the broadening of our Caribbean partnerships through the signing of a general agreement with the Ministry Agriculture in Cuba; the installation in December of our new Board of Trustees; the continuation of our efforts to achieve financial recovery and the ongoing priority given to employment policy and, internally, the launch of 23 projects covered by our resource development pact.

And let's not forget our many research results, which have given rise to many recognized publications! Lastly, despite a global context marked by increased terrorist activity in our country and elsewhere, we have continued to see many admirable actions, a dynamism, a supportive and brotherly collective spirit and a determination to adapt to and overcome difficulties. Bravo and thank you to each and every one of you for this unflinching commitment!

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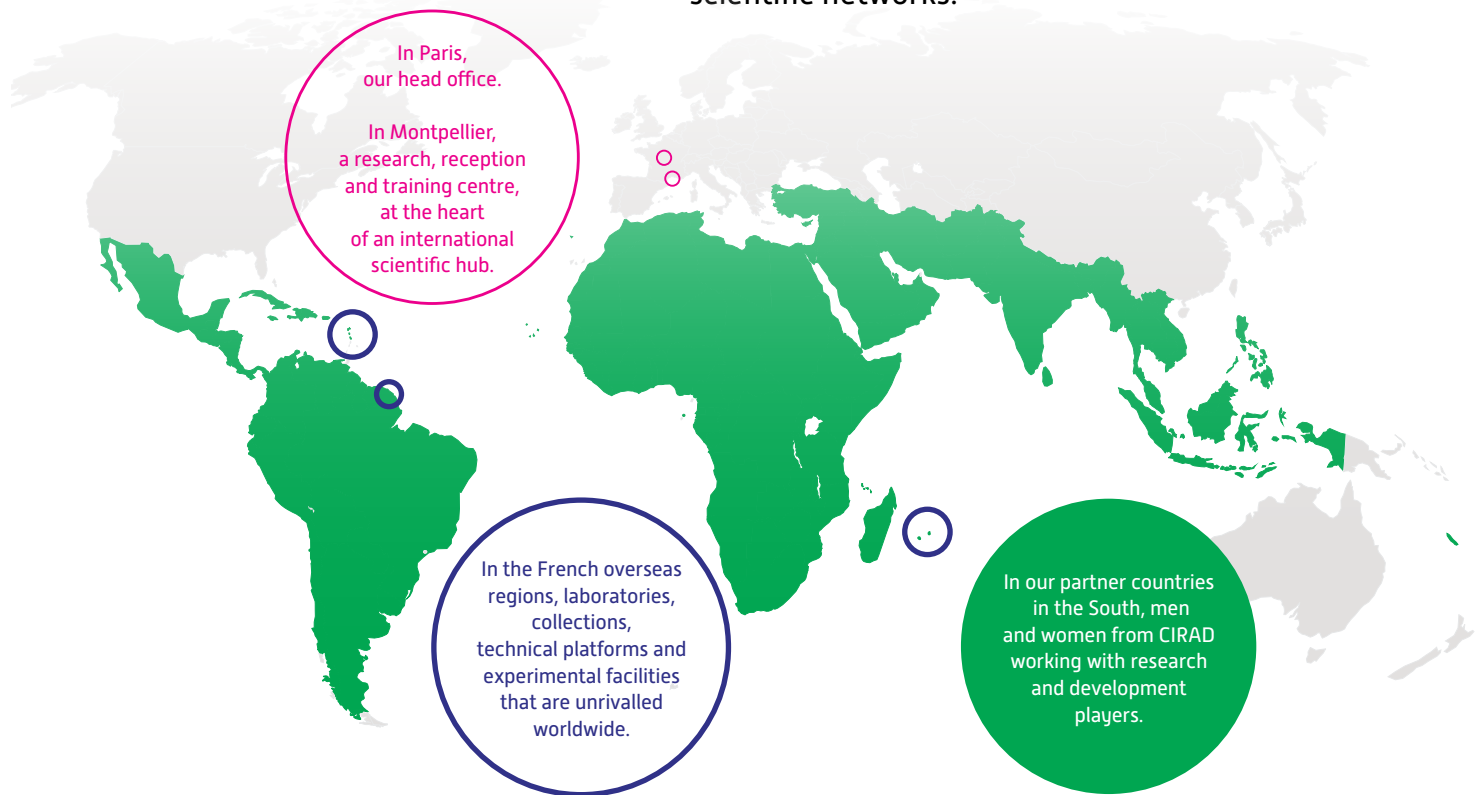
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CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions

> CIRAD's recognized expertise in agricultural issues in the South makes it a European reference in global scientific networks.



> Its scientific operations respond to the needs of local populations and the main issues facing agriculture worldwide.

> CIRAD is a targeted research organization that sees partnership as one of the cornerstones of its scientific strategy.

Working
together
for tomorrow's
agriculture

> The men and women working at CIRAD come up with novel solutions tailored to the needs of rural societies and their environment.

> Partnership is both a means and an end for them.

> These men and women are committed to building sustainable farming systems capable of feeding 9 billion human beings by 2050.



1650

staff members

A budget of
€ 200M in 2014

1st agricultural research player
in the French overseas regions

TRAINING



5400 hours of teaching each year

300 PhD students supervised each year,
including **200** from southern countries

A partner in **120** higher education courses
(Masters to PhDs) in France and abroad

PARTNERSHIP



400 researchers assigned abroad

19 000 days of missions/year

Activities in more than **100** countries,
in partnership with **150** organizations

RESEARCH



800 journal articles per year,

including **400** co-publications with
researchers from partner countries

800 researchers and technicians from
all over the world received each year

More than **20** research and training platforms
in partnership worldwide

INSTITUTIONAL HIGHLIGHTS 2015 >

Certain plant species are remarkably resistant to climate
change and well suited to a desert climate, Australia
A. Rival © CIRAD

LIFE AT CIRAD

Sustainable development and social responsibility

CIRAD signed the Sustainable development charter for public establishments and enterprises in 2014. This should result in quality assurance and continuous improvement approaches in its governance, its management methods and its activities.



An overview with
Léandre Mas,
CIRAD Coordinator
for Quality and
Sustainable Development

Which areas are covered by social and environmental responsibility at CIRAD?

Léandre Mas: Many areas are concerned. For our research activities, by adhering to the Charter we undertake to provide reliable knowledge, findings, expertise, training and services to meet demand, in an effective and expeditious manner within the time specified. But we also undertake to protect the environment, employee health and natural resources, and to ensure social equity and cost reduction. In addition, our adhesion implies managing risks, especially those perceived by public opinion, and may require technological innovations in terms of energy, for example. The whole establishment is concerned by these commitments.

How exactly are decisions made and implemented?

L.M.: An initial report on action undertaken was presented to the board members on 15 December. It illustrates the four pillars* of social and environmental responsibility: governance, social commitment, eco-responsible and environmental commitment, and territorial and economic responsibility.

This report describes an internal approach that began in 2015 with a preliminary organisational

analysis of CIRAD and its environment, based on the AFAQ 26000 assessment model. The goal is to define the establishment's environment, the stakeholders forming its internal and external network, the distribution of responsibilities, its strengths, weaknesses, resources and constraints, and finally its primary objectives. It should lead to the collective development of a multi-year strategic plan for sustainable development, which will be regularly monitored and audited.

How will progress made be measured?

L.M.: Results are expected in three fields – environmental, social and economic – for which AFAQ 26000 proposes indicators.

The first report shows that there are many different initiatives, but that these are fragmented. It could be worth adopting an integrative approach that would impact on the whole organisation. This is the global approach CIRAD is striving to adopt in order to pool its resources and to create synergies. Some measures have already been taken to achieve this.

Ultimately, the establishment should derive many benefits from this, especially greater attractiveness for current and future employees, partners and clients, who are increasingly voicing their sustainable development expectations. If CIRAD leads by example, it will improve its image.

* These pillars are defined according to the "Principles and guidelines for social responsibility in public organisations" published by the French Ministry of Ecology, Sustainable Development and Energy with the Club Développement Durable des Etablissements Publics et Entreprises Publiques (sustainable development club for public establishments and enterprises).



Employment and disability: giving everyone a chance

On 16 November, the human resources department took part in the 6th edition of the Handijob Forum in Montpellier. More than 70 CVs were collected and could lead to internships, temporary assignments, professional training contracts, or even permanent contracts. Since 2014, CIRAD has exceeded the 6% quota for hiring and retaining people with disabilities, which is compulsory for companies with 20 employees or more.



Lavalette is heated with green electricity. On CIRAD's main site in Montpellier, Lavalette, 290 high-performance sensors and 210 m² of solar panels cover the boiler room roof. This technology is 100% French. A total of 5% of the site's heating requirements will thus be covered by solar, 60% by wood and the remaining 35% by gas.

Working conditions: 70% satisfaction for CIRAD staff. Good working conditions contribute not only to employee well-being but also to company productivity. Satisfaction rates are higher than the national average of 63%.

If CIRAD leads by example, it will improve its image.

Appointments

Nicolas Bricas, a socio-economist at CIRAD, became Director of the UNESCO Chair in World Food Systems at Montpellier SupAgro, supported by the Agropolis Foundation and the Daniel and Nina Carasso Foundation. Its goal is to build and disseminate knowledge on world food systems. <http://www.chaireunesco-adm.com>



Patrick Caron, Director General in charge of Research and Strategy, was elected Chairperson of the UN Committee on World Food Security High Level Panel of Experts (HLPE) on Food Security and Nutrition. <http://www.fao.org/cfs/cfs-hlpe>

Mohammed Rochdi, President of the University of Reunion, joined CIRAD's Science Council. He is also Vice-President of the Technopole de la Réunion (Reunion technopole), which has managed Reunion's regional business incubator since April 2011, and Vice-President of the Qualitropic competitiveness cluster.

Jacques Tassin, a researcher in ecology, was chosen as an expert to IPBES, biodiversity's equivalent to the IPCC. He specialises in invasive species. <http://www.ipbes.net/>



Laurence Tubiana, France's Special Representative for the 2015 Paris Climate Conference, is also a member of CIRAD's Board of Trustees, which has benefited from her vision of the challenges for COP21 research.



Anne-Lucie Wack became the first female Chair of the Conférence des Grandes Écoles (CGE – French association of prestigious universities). She is an ingénieure générale des Ponts, des eaux et des forêts, and is currently Director General of Montpellier SupAgro, having spent more than 15 years at CIRAD.

The resource development pact

CIRAD is innovating and launching two incubators

CIRAD is launching two incubators, one for major projects and the other for new products and services.

Incubators are a new support method at CIRAD to enable the emergence of major projects and new products and services by providing project managers with:

- dedicated financial resources through incentive actions;
- specific support throughout the life of the project;
- recognition of responsibilities.

The goal is to strengthen the service offering to donors or companies. Project managers will benefit from financial resources thanks to dedicated incentives and will receive specific help from support services (lobbying, development, management, training, etc.).

François Pouget, Paris, France,
Director General in charge of Resources and Organisation



A product example: the ovine rinderpest vaccine.
© Biopharma

• The “Major projects” incubator will mobilise research teams in the development of far-reaching multi-disciplinary projects that tie in with the goals of CIRAD's scientific partners, supervisory ministries and donors, based on relevant, innovative research questions.

• The “Products and services” incubator will identify potentially transferable innovations within laboratories and will support their improvement, in partnership with companies or development structures (Sociétés d'Accélération du Transfert de Technologies, SATT – technology transfer acceleration societies; Consorti-ums de Valorisation Thématique, CVT – thematic development consortiums, etc.).

Two CIRAD-INRA Joint Consultative Committee on Ethics statements

Training in and through research: what are the ethical issues? (January 2015)

The 6th statement of the Committee on Ethics stresses the importance to be attached to the quality of support given to students welcomed within research units, and to strict compliance with the rules of ethics when introducing students to research. It naturally refers to the French National Charter for Research Integrity, which CIRAD signed that month in an international context of repeated challenges to scientific integrity.

Through this choice, the committee encourages greater reflexivity in terms of the goals and practices involved in hosting and training young researchers. Training in and through research is a powerful indicator of the values the establishments want to defend, which is particularly relevant in the field of international cooperation.

The welfare of farm animals (October 2016)

The 7th statement of the Committee on Ethics centred on farm animals, excluding laboratory animals and pets. The aim is not to determine whether animals adapt to the conditions to which they are subjected in order to ensure productivity, but to examine ways of adapting livestock farming conditions to the needs and behaviour of animals.

Philippe Feldmann, Montpellier, France, Secretary of the Committee on Ethics

LIFE AT CIRAD

Substantial support for infrastructures

CIRAD in Languedoc-Roussillon has been granted five million euros to build research infrastructures and renovate some of its buildings and greenhouses within the framework of the Contrats de Projets État-Région (CPER – State-region project contracts) 2015-2020, which were signed at the end of July.

A new S2-type greenhouse will be built using the 2.5 million euros of funding for the ReSeM project (Réseau des Serres Montpelliéraines – Montpellier greenhouses network, which also includes INRA, IRD and CNRS). With 1.6 million euros for the TechAlim project, the agri-food technology platform will acquire new equipment, the sensory analysis laboratory will be renovated and installations will be upgraded to meet standards. With a total amount of 850 000 euros, the EcoCampus project will focus on improving energy efficiency in CIRAD's Lavalette buildings, in other words thermal insulation, solar energy and network revision.

CIRAD will also benefit from funding obtained through other projects: the ARCAD 3 project [3.4 million euros] will enable the acquisition of heavy equipment within the framework of the future ARCAD plant genetic resources centre; and the MesoLR project [5.6 million euros] will set up a data and computing centre, a tool intended for use by all scientific establishments in the region.

Michel Salas, Montpellier, France, Regional Director for Languedoc-Roussillon

The human aspect of biodiversity, by Gilles Boeuf

"This can't go on, it's time to act...". In a fascinating, impassioned speech given to a full house during CIRAD's 2015 conference, Gilles Boeuf, Chair of CIRAD's Science Council and Advisor to Ségolène Royal, told the story of human relations and explained what is in store for the world if people do not change their ways.

Watch the video on YouTube.



Panther chameleon in Madagascar
© P. Lachenaud/CIRAD



Awards

Jeremy Bouyer (middle), veterinarian and entomologist specializing in vector ecology and control and Head of UMR CMAEE, was awarded CIRAD's first ERC grant in a highly competitive EU tender, as well as the Prix de la Francophonie pour Jeunes Chercheurs (Francophone prize for young researchers) from the Agence Universitaire de la Francophonie (AUF – Francophone university association) for his research on tsetse fly ecology and control, and on the epidemiology of vector-borne diseases.



© CIRAD

Églantine Fauvelle, an agronomist specializing in the dynamics of changes in forest socio-ecosystems, was awarded the Xavier Bernard prize by the Académie d'Agriculture de France (French agriculture academy) for her research on participatory modelling.



© CIRAD

Claire Lanaud, a cocoa genetics and genomics researcher, was awarded the Louis Malassis Prize 2015: this prize recognises her extensive scientific contribution to knowledge of the cocoa genome and its many applications for development in the countries of the South.



© Prix Louis Malassis

Mathieu Roche, a computer science researcher in the TETIS laboratory, designated as the Languedoc-Roussillon "2015 Researcher of the Future", was awarded funding for his project entitled "SONGES – Science des Données Hétérogènes" (Heterogeneous data science), which is intended to increase the visibility of CIRAD's digital heritage.



© CIRAD

PARTNERSHIPS

FRANCE

CIRAD is now a member of the *Institut Agronomique, Vétérinaire et Forestier de France**

The decree establishing the Institut Agronomique, Vétérinaire et Forestier de France (IAVFF) appeared in the French Official Journal of 31 March. This structure associates 14 establishments, including CIRAD. It takes over from AGREENIUM, whose name it will carry.

The goal of the institute is to design and implement research strategies and joint training for its members, at the national, European and international levels. The members will coordinate their policies and international activities within this framework, in line with what has already been done by AGREENIUM. To this end, the institute coordinates training of teaching and supervisory staff in the agricultural technical education sector. It will also coordinate training for engineers in fields covered by the Ministry of Agriculture, and will be responsible for updating the veterinary studies framework and designing veterinary clinical research programmes.

The new AGREENIUM/IAVFF Institute will be located in CIRAD's Paris premises, which will also accommodate IRD. Thanks to these new arrivals, the Parisi site on Rue Scheffer is in the process of becoming an "International Agrosience for development Campus". CIRAD's regional directors throughout the world also represent AGREENIUM/IAVFF.

Christian Hoste, Director of International Relations for AGREENIUM, christian.hoste@iavff-agreenium.fr
<http://www.iavff-agreenium.fr/>

* French agricultural, veterinary and forestry institute

Events

"Multifunctional farming systems in a changing world". A number of CIRAD researchers presented their approach to agroecology at **Agro2015, the 5th international symposium for Farming Systems Design (FSD)**, an international scientific network. The SYSTEM joint research unit was closely involved in organising this conference in Montpellier from 7 to 10 September, which was attended by 400 scientists from 40 different countries. It was co-organised by the European Society for Agronomy (ESA) and Agropolis International.

<http://fsd5.european-agronomy.org/presentations.html>

Annick Girardin, French Minister of State for Development and Francophony to the French Ministry of Foreign Affairs and International Development, **paid a half-day visit to CIRAD in Montpellier on 18 September**. Researchers presented some of CIRAD's flagship initiatives. The United Nations General Assembly in New York on the

Sustainable Development Goals and COP21 in Paris were discussed.



Claire Chevassus explains the principle of the "RHIZOtest" to Annick Girardin © M. Adell/CIRAD

CIRAD has transferred its aquariums and aquaculture basins to the **MeDITERA marine centre of excellence managed by IFREMER**, in Palavas-les-Flots, in order to work on tilapia and integrated multi-trophic aquaculture. The new structure, which now covers almost 6000 m², was inaugurated on 13 October in the presence of the Prefect for Languedoc-Roussillon.

Agreements

A framework agreement between the **Agence Française de Développement (AFD - French development agency)** and CIRAD was signed on 14 January in Paris for a five-year period by Anne Paugam, Director General of AFD, and Michel Eddi, President of CIRAD, in the presence of Annick Girardin, French Minister of State for Development and Francophony.



Michel Eddi and Annick Girardin signing the agreement © French Ministry of Foreign Affairs and International Development

On 18 June, **CIRAD, CNES, CNRS, IGN, IRD and IRSTEA signed a contract with Airbus Defence and Space** for a five-year period. They will receive very high resolution satellite images from the SPOT 6-7 satellites. On the same day, the six organisations also signed up to the creation of a consortium aimed at setting up a new institutional remote sensing sector for use by the territories.

The **European LABEX (virtual laboratory) of Universiti Putra Malaysia** at Agropolis was created on 27 July for a five-year period. This LABEX joins the two already hosted in Montpellier, the EMBRAPA (Brazil) LABEX Europe and Labintex - External Laboratory without walls of the Instituto Nacional de Tecnología Agropecuaria (INTA) - Argentina.

Events



At Expo 2015 in Milan, from 13 May to 21 October, CIRAD researchers took part in 11 round tables and conferences organised within the framework of the "Mercredis du Pavillon de la France" (French Pavilion Wednesday meetings).



Pierre de Bousquet, Prefect for Languedoc-Roussillon, Vincent Rigaud, Director of IFREMER's Mediterranean centre and Michel Salas, President of CIRAD's Montpellier centre © M. Adell/CIRAD

PARTNERSHIPS EUROPE

Launch of ProIntensAfrica

The ProIntensAfrica project was launched during a workshop in Accra, Ghana, in April. This two-year project is aimed at developing all areas of the IntensAfrica programme, a long-term research partnership between Europe and Africa, and at validating its feasibility.

The core idea is to explore and exploit the wide range of options for the sustainable intensification of farming and food systems in Africa, while creating an enabling policy environment. More than 10 representative case studies have been identified and a common analysis methodology has been developed.

This project is one of the building blocks of the "Roadmap towards an EU-Africa Research & Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture", which will be approved in April 2016 in Addis Ababa during the next Europe-Africa summit. Philippe Petithuguenin coordinated its preparation on behalf of the "EU-Africa High Level Policy Dialogue" expert group.

Florent Maraoux,
Montpellier, France,
CIRAD ProIntensAfrica
Coordinator

Philippe Petithuguenin,
Montpellier, France,
Deputy Director General in
charge of Research and Strategy

<http://www.intensafrica.org/>

ProIntensAfrica is financed by the EU H2020 programme. Led by CIRAD, Wageningen University (WUR) and the Forum for Agricultural Research in Africa (FARA), it involves scientific partners from 13 European countries and a number of African countries, especially in West Africa.



Smallholder agroforestry system:
palms and lowland rice (Forest Guinea)
© E. Penot/CIRAD

Networks and bodies

CIRAD was tasked in late 2015 with coordinating the "Europe, International et Sud (Europe, International and South)" group of the **AllEnvi** environment alliance.

Philippe Petithuguenin is Co-Chair of the **European working group ARCH**, comprised of representatives of the European Initiative for Agricultural Research for Development (EIARD) and members of the Standing Committee on Agricultural Research (SCAR).

CIRAD is strengthening its relations with the members of **AGRINATURA** (18 European countries) and those of the EURAGRI network. The European Commission (DG DEVCO) has awarded two direct agreement contracts to the EEIG AGRINATURA involving 10 CIRAD researchers:

- The goal of the **Capacity Development for Agricultural Innovation Systems (CDAIS) (2015-2018)** project is to reform agricultural innovation systems in eight countries of the South (Laos, Niger, Rwanda, Ethiopia, Bangladesh, Honduras, Venezuela and Angola), especially by means of training and support for innovation process facilitators. It is being implemented with FAO (through the Tropical Agriculture Platform) and the national authorities in the countries concerned.

- The **National Information Platforms for Nutrition (NIPN)** initiative is part of an ambitious programme to reduce chronic malnutrition in children in the countries most affected by this problem. AGRINATURA runs its coordination unit (the Global Support Facility, GSF).

Events

Many researchers contribute actively to events organised by the European institutions. They are also involved in their organisation:

- > Patrick Caron, Director General in charge of Research and Strategy, and Bruno Losch, a researcher in political economics, took part in the **European Development Days 2015** on 3 and 4 June in Brussels.

- > CIRAD received a delegation from the European Commission during the conference on **Climate-Smart Agriculture in Montpellier** (16-18 March). This visit was the opportunity to discuss some of CIRAD's flagship activities in southern Africa, where CIRAD is the coordinator for a major future project financed by DG DEVCO.

Jean-Michel Sers, Montpellier, France,
European Affairs Coordinator

PARTNERSHIPS INTERNATIONAL

A roadmap for the Platforms in partnership for research and training (dPs)

Through its platforms in partnership for research and training (dPs), CIRAD has developed a unique network of more than 150 research and higher education establishments and intergovernmental organisations, from both civil society and the private sector in tropical and Mediterranean regions.

The dPs will have a key role to play within the international bodies concerned with the planning, governance and implementation of international agreements. In order to make them stronger, CIRAD has worked to ensure each dP produces a five-year action plan, covering the same period as those of the research units (2015-2019). Each dP plans and organises its activities in close collaboration with its partners, according to its own roadmap and specific schedule.

There are plans to build bridges between some dPs and IRD joint laboratories and to apply for regional labelling, as in West and Central Africa with WECARD, or international recognition (European Union, CGIAR, Forum for Agricultural Research in Africa, etc.) through the AllEnvi Alliance.

Jacques Pagès, Montpellier, France
Platforms in Partnership Coordinator

A total of 21 PPs have been labelled since 1 January 2012, for a five-year period. Two others were labelled on 1 January 2016, for a two-year period: "Innovation and plant breeding in West Africa" (IAVAO) and the "One Health Network - Indian Ocean" (ONE HEALTH IO).



Events

Michel Eddi took part in the France-FAO Strategic Dialogue in Rome on 1 and 2 April, a yearly meeting at which climate change and COP21 were discussed, among other issues.

Patrick Caron took part in the Global Forum on Agricultural Research (GFAR) Constituent Assembly in Bangkok from 24 to 26 August. The 100 participants provided strong support for the reform and renewal of the GFAR in terms of its vision, mandate and governance, with a roadmap.

Michel Eddi and Patrick Caron attended the United Nations Summit on the Sustainable Development Goals in New York from 24 to 27 September.

A side event was organised at the UN Headquarters on 25 September by IRD, CIRAD, Columbia University and the Permanent Mission of France to the United Nations in New York on "The scourge of climate-related diseases in vulnerable regions".

Agreements

CIRAD is involved in several major projects on family farming, proposed in the report submitted to the government on 26 January, on France's commitment to the International Year of Family Farming.

A framework agreement was signed with the Inter-American Institute for Cooperation on Agriculture (IICA) in Montpellier on 16 March, during the visit of the Director General of IICA, Victor M. Villalobos, to support the development of agricultural and rural territories in Latin America and the Caribbean.

A five-year agreement was signed with the International Association of Advances in Research and Development (IAARD): Agung Hendriadi, Executive Secretary of IAARD, and Michel Eddi for CIRAD thus established a general framework for joint research to be conducted by both organisations during the IAARD delegation's visit to Montpellier.

PARTNERSHIPS

CARIBBEAN INDIAN OCEAN

CIRAD is developing future cooperation on agricultural science with its Caribbean partners

Around 100 agricultural research and development stakeholders from 15 Caribbean countries and territories worked on the future of scientific cooperation, from 17 to 19 November in Guadeloupe. A report was presented on projects conducted as part of the European Interreg IV programme. Based on these results, CIRAD and its partners have proposed a vast regional project for the 2015-2020 period integrating the banana, plantain, fruit and vegetable sectors, animal and plant health, agroecological practices and a Caribbean agriculture monitoring centre.

Different initiatives accompanied the launch of this integrated structural project in 2015, with the support of the Interreg IV programme. Where plants are concerned, research requirements were analysed for six crops of major importance: citrus, pineapple, banana, coffee, yam and tomato. For soil, the project supported the development of CIRAD's Soil Ecology and Biology laboratory in Martinique. For animals, action involved capacity building for the surveillance and diagnosis of priority diseases in the Caribbean, especially avian influenza. Finally, the project launched discussions

on the public policies and strategies of stakeholders involved in the sustainable development of these sectors, with a view to developing the future Caribbean agriculture monitoring centre. Eleven territories were involved: Guadeloupe, Martinique, Cuba, Jamaica, Trinidad and Tobago, Dominican Republic, Haiti, Dominica, Saint Lucia, and Saint Vincent and the Grenadines.

Dominique Martinez, Capesterre-Belle-Eau, Guadeloupe, CIRAD Regional Director West Indies-French Guiana

Participants in workshops to develop CIRAD's Caribbean project on agriculture and environment, in November in Guadeloupe © S. Della Mussia, CIRAD



Events

Stéphane Le Foll, French Minister of Agriculture, and Michel Eddi, President of CIRAD, travelled to the West Indies in January. *"What I have seen today during my visit to CIRAD in Guadeloupe particularly encourages me to continue the agroecology plan for France, which I launched in late 2012",* said the Minister following his visit to CIRAD's Neufchâteau station in Guadeloupe, referring to the different agroecological research programmes and, in particular, to the Sustainable Banana Plan. *"Your research and transfer teams have shown me once again that a more sustainable agriculture is possible".*



Stéphane le Foll at CIRAD's Neufchâteau station in Guadeloupe © D-L. Aubert, DAAF Guadeloupe

110 animal health sector stakeholders from the Caribbean and Europe met in Guadeloupe for one week in late April in order to take stock of emerging diseases in the Caribbean. The steering committee for the European Epigenesis project met ahead of these meetings, which also involved the members of the CaribVET Caribbean network.

The Cabaré project closing seminar was attended by 75 Caribbean participants from 24 to 26 June in Guadeloupe. This project assessed agricultural performances and resistance to black Sigatoka in four hybrid varieties created by CIRAD (in Guadeloupe) and INIVIT (in Cuba), but also the impact of seedling production methods on viral risk.

Emmanuel Macron, French Minister of the Economy, Industry and Digital Affairs, was received by the wood science laboratory in Kourou on 20 August. He was accompanied by Eric Spitz, Prefect for French Guiana, Rodolphe Alexandre, President of the Regional Council, Senator Antoine Karam and a delegation of local officials.



Events

A high-security laboratory was inaugurated in Guadeloupe on 30 October. Attached to the *Centre Caribéen de Recherche et de Veille sur les Maladies Infectieuses Animales et Zoonotiques* (Caribbean centre for research and surveillance of infectious animal and zoonotic diseases), this new CIRAD laboratory will study infectious pathogens, such as West Nile virus. This unique structure in the Caribbean complements the platforms for high speed diagnosis, sequencing and proteomics acquired by CIRAD as part of the European Epigenesis project. The centre's facilities are all pooled and available to the local and regional scientific community.



Official inauguration of the CIRAD P3 laboratory at Duclos. L to R: Dominique Martinez, Nathalie Vachier, Philippe Dezac, Richard Nébor, Pol Kermorgant © CIRAD

A day of information and discussions on the ways climate change is impacting forest management in French Guiana was held on 2 February at the *Cité Administrative Régionale* centre in Cayenne, bringing together operators from all parts of the forestry sector, from research to economics. This important event, organised by CIRAD and Guyane Energie-Climat, in partnership with the French Guiana Region, was the first in a series of events held throughout 2015 on climate change in French Guiana.

Two other meetings with forestry sector stakeholders were held in March and October to **present data obtained over the last 30 years by CIRAD and ONF on experimental plantations of local tree species for timber production**. This data is now used to recommend the species to be planted depending on the volumes of timber required and the uses planned, but also according to their ability to adapt to climate change [resistance to higher temperatures and harsher dry seasons]. These future plantations could one day replace logging in natural forests, which need to be protected, especially because of their role in the regulation of rainfall.

Agreement

In Cuba, Michel Eddi and the Ministry of Agriculture, represented by Maricela Diaz Rodriguez, signed a framework agreement on 6 March in Havana, in the presence of the French Minister of State for Foreign Trade and the French Ambassador to Cuba.

Diversinervus,
micro-wasp
parasitoid of the
cochineal, used in
biological
pest control
© A. Franck/CIRAD



Microportraits

The hidden creatures of our crops

CIRAD's photo exhibition on crop insect biodiversity toured Reunion and Mauritius. The photos are taken from an image bank for the identification of insects and spiders of the south-west Indian Ocean region. Antoine Franck, an entomologist and photographer at CIRAD in Reunion, produced the photos using an imaging system composed of a macroscope (with a magnification of 0 to 400x)

combined with a photographic module. This exhibition is part of the ePRPV project (Enlargement and Sustainability of the Plant Protection Network), which promotes agroecology and biodiversity. It is co-financed by the EU, France, the Reunion Region, the Reunion Department and CIRAD, and receives support from the Indian Ocean Commission.

Antoine Franck, Saint-Pierre, Réunion

Genetic resources

COREBIO, working for good practice

Understanding, protecting and promoting the agricultural plant genetic resources (APGR) available in the Indian Ocean region in order to improve food security there is the goal of the GERMINATION project. The second phase of this project, launched in 2015, is based on a network covering six south-west Indian Ocean countries. To support the GERMINATION project, in Reunion in January 2015 CIRAD's biological resources committee [COREBIO] provided training on the legal aspects of agricultural plant resources for around 20 participants from the six countries. During this training course, the project partners established a good practice guide. In addition to the assistance it may provide for the transfer of genetic materials in a rapidly changing international context, this guide proposes a framework to facilitate co-operation within the network. The training programme was also aimed at presenting a common language for decision makers, illustrated by examples, specifying what is important for research and what is important for the communities involved.

Claire Neirac, Dominique Dessauw, Montpellier, France, COREBIO

Michel Roux-Cuvelier, Saint-Pierre, Réunion, Germination II Coordinator

<http://umr-pvbm.cirad.fr/principaux-projets/germination-ii>

<http://www.agriculture-biodiversite-oi.org/>

Within the Office of the Director General, the goal of **CIRAD's biological resources committee (COREBIO)** is to improve and align biological material exchange procedures, from a technical, legal and ethical viewpoint. It also strives to improve the management and recognition of the resource collections to which CIRAD contributes, helping to structure them within biological resource centres (BRCs) and networks. To do so, it takes part in amendments to international, regional and national legislation and to intellectual property rights associated with living organisms and promotes good practice in access and benefit sharing (ABS) in CIRAD's partnerships. COREBIO is increasingly active in research project design and organises training courses for CIRAD's researchers and partners.

PARTNERSHIPS

AFRICA

CIRAD is strengthening its presence in Southern Africa

During his visit to southern Africa from 12 to 18 October, Michel Eddi signed four cooperation framework agreements involving the Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) and four universities in South Africa and Zimbabwe: the Universities of Pretoria, Stellenbosch and Zimbabwe (UZ) and the National University of Science and Technology (NUST).

The goal is to develop new scientific partnerships between Réunion, Madagascar and southern Africa. To achieve this, CIRAD will mobilise the 100 researchers working in the zone within five platforms in partnership: in Southern Africa, Production and conservation in partnership (RP-PCP) and Public policy and governance in Southern Africa (GOVINN); in Madagascar, Highland production systems and sustainability (SPAD) and Forests and biodiversity (F&B); and One Health in the Indian Ocean.

Jacques Lançon, Nairobi, Kenya, Regional Director East and Southern Africa

<http://afrique-orientale-australe.cirad.fr/>



Signing the renewal of the agreement on the dP RP-PCP.

From left to right: the French Ambassador to Zimbabwe, Laurent Delahousse, the Vice Chancellor of NUST, Lindela Ndlovu, the CNRS representative in Southern Africa, Jean Albergel, the Director of TREP-UZ, Shakkie Kaztivu and Michel Eddi

© M. De Garine, CIRAD

The agreement with **CCARDESA**, which coordinates agricultural research and development in the region covered by the Southern African Development Community (SADC), strengthens cooperation between the two organisations in a regional framework, SADC and Indian Ocean.

Stellenbosch University shares some problems with CIRAD in Reunion regarding the quality of food products; the agreement was signed after several assignments involving CIRAD's regional directors and a visit by a Stellenbosch University delegation to Réunion.

Through the agreement with the **University of Pretoria**, CIRAD and UP join the governance of the GovInn centre of excellence (Innovation in governance), a laboratory with a continental dimension.

The agreement linking CIRAD and CNRS to the **Zimbabwean universities UZ (Harare) and NUST (Bulawayo)** around the platform in partnership for research RP-PCP consolidates an ambitious, original scientific partnership on the sustainable management of territories belonging to protected areas.

General agreements

> With the **National Research Foundation (NRF)** in South Africa. This is the first framework agreement associating the three main French international research institutions under the authority of the French Ministry of National Education, Higher Education and Research: CIRAD, IRD and CNRS.



From left to right, the five signatories to the agreement: P. Nédellec, G. Pillay, E. Barbier, J. Lançon and J.-P. Moatti
© J. Lançon/CIRAD

> With the **Interprofessional Fund for Agricultural Research and Advisory Services (FIRCA)**, during the 3rd Agriculture and Animal Resources Fair of Abidjan (SARA) on 4 April, with Pierre Ackah Angniman, Executive Director of FIRCA.



Pierre Ackah Angniman and Patrick Caron © CIRAD

> With the **Centre National de la Recherche Scientifique et Technologique (CNRS - National centre for scientific and technological research)** in **Burkina Faso**, in the presence of the Minister of Scientific Research and Innovation and the Directors of the four member research institutes (including INERA), in Ouagadougou on 20 April.

> With the **Centre National de Lutte Antiacridienne (CNLA - National locust control centre)** in **Mauritania**, in Nouakchott on 27 May.

> With the **Permanent Interstate Committee for Drought Control in the Sahel (CILSS)** for the planning of the Regional Sahel Pastoralism Support Project (PRAPS) financed by the World Bank, in Paris on 28 May.

Resource pooling is continuing. The IRD and CNRS representative is now CIRAD's correspondent in South Africa, and CIRAD's correspondent in Zimbabwe is now an IRD-CNRS correspondent.

Events

A very high level Kenyan delegation from the Ministry of Education, Science and Technology (MOEST), led by Professor Collette Suda, Minister of State for Science and Technology, was received by CIRAD and AGREENIUM in Montpellier on 23 September.

The Govinn Governance Innovation Week 2015 was organised by the University of Pretoria and CIRAD from 1 to 6 June: six workshops addressed the external dimension of EU environmental policy, beyond GDP economic paradigms, inclusive development, regions without borders, new studies on regionalism and, finally, Europe-Africa relations.

At ILRI's invitation, a delegation from CIRAD led by Philippe Vernier, International Relations Coordinator, and Jacques Lançon, Regional Director, visited Nairobi on 9 and 10 June to identify ways of strengthening partnerships.

CIRAD's participants © CIRAD



CoForSet "Congo Basin Forests: Scenarios of Biodiversity and Offsetting Mechanisms" was officially launched on 6 May. This project, coordinated by CIRAD, is financed by the Fondation pour la Recherche sur la Biodiversité (FRB - Foundation for research on biodiversity) and the Fonds Français pour l'Environnement Mondial (FFEM - French global environment facility). It studies environmental offsetting mechanisms linked to mining projects under development in the TRIDOM cross-border conservation zone. The Congo Basin forests are subject to growing pressure from the mining industry and from infrastructure development. Offsetting is emerging as a possible response to these impacts.

Claude Garcia, Zürich, Switzerland
Hélène Dessard, Montpellier, France

<http://www.cofortips.org/>

Cooperation agreement with six African universities

CIRAD and the member institutions of the Ecole Doctorale Economie et Gestion de Montpellier (Montpellier graduate school in economy and management) (University of Montpellier, University Paul Valéry, Montpellier SupAgro) signed a cooperation framework agreement with six African universities: Abomey Calavi in Benin; Cheikh Anta Diop-UCAD in Senegal; Félix-Houphouët-Boigny in Ivory Coast; Ouagadougou in Burkina Faso; Omar-Bongo in Gabon; and Yaoundé II in Cameroon. This agreement illustrates one of the key objectives of CIRAD's mandate: capacity building for researchers in the countries of the South in collaboration with higher education. It is also the first cooperation framework agreement signed between such a large number of African universities and the Montpellier higher education community.

Magali Dufour, Montpellier, France, Higher Education and Training Officer



The 6 African universities: Abomey Calavi in Abomey Calavi in Benin; Cheikh Anta Diop-UCAD in Senegal; Félix-Houphouët-Boigny in Ivory Coast; Ouagadougou in Burkina Faso; Omar-Bongo in Gabon; Yaoundé II in Cameroon

◀ Lecture, Masters in environmental economics of rural development and agri-food at the University of Yaoundé II, led by Ludovic Temple and Sandrine Dury, economists at CIRAD. © J.-R. Minkoua

Fostering regional research synergies with WECARD

The 2015-2018 Action Plan, signed on 1 June by Paco Sérémé, Executive Director of the West and Central Africa Council for Agricultural Research and Development (CORAF/WECARD) and Denis Depommier, CIRAD Regional Director in Dakar, is primarily aimed at strengthening regional synergies in agricultural research for development (ARD). The ultimate goal is to optimise and extend the impact of agricultural innovations on food security and nutrition in the countries concerned and on their environmental resources. To this end, ensuring closer linkages or even partnerships between existing research mechanisms, the National Centres of Specialisation (NCoS) promoted by CORAF/WECARD and the platforms in partnership for research (dP) promoted by CIRAD, is the key application of this action plan. The dP PPZS and the NCoS Livestock (Niger), the dP DIVECOSYS and the NCoS Fruit and vegetables (Burkina Faso), and the dP IAVAO and the NCoS Dry cereals and associated crops (Senegal) are specific examples of this.

<http://afrique-ouest-continentale.cirad.fr/>

Laying the foundation stone of Cheikh Ibrahima Niasse University in Senegal

The new University of Sine Saloum de Kaolack (USSK) in Senegal, now known as Cheikh Ibrahima Niasse University, is part of the Emerging Senegal Plan (ESP), which acknowledges agriculture as the driver of economic development, within a harmonious territorial and social framework. The foundation stone was laid on 13 April under the high patronage of the President of the Republic of Senegal, Macky Sall, and under the coordination of the Chancellor of the University, Professor Amadou Tidiane Guiro.

<http://afrique-ouest-cotiere.cirad.fr/>



PARTNERSHIPS

SOUTH AMERICA

CIRAD, a long-time partner of the University of Brasilia Center for Sustainable Development

The Center for Sustainable Development (CDS) was created 20 years ago at the University of Brasilia (UNB). CIRAD and INRA renewed their framework agreements with UNB in 2014 and 2015. Bernard Mallet, Regional Director for Brazil, signed a joint work programme 2015-2020 with Doris Sayago, Director of the CDS, during the centre's 20th anniversary celebrations in December.

The partnership with the CDS is very fruitful. Several projects involve teams from the dPs Public Policy and Rural Development in Latin America (PP-AL) and AMAZONIE. These include: CN-Pq-Transbrasil, H2020-Odysea, Capes Agropolis-SocioBiocerrado, and Rede Clima regional development. Researchers from the International Joint Laboratory Observatoire des Changements

Environnementaux (OCE - Observatory of environmental change), jointly coordinated by IRD at UNB, take part in it. The partnership also involves the organisation of joint training programmes and seminars, such as the one held in October 2015 in Brasilia as part of preparations for COP21, with around 20 researchers from eight countries (Brazil, Chile, Colombia, Costa Rica, France,

Mexico, Peru and Uruguay), to examine the public policy instruments implemented in Latin America to address climate change, in relation to agriculture, environment, forests and rural areas.

Jean-Luc Battini,
Regional Director for Brazil



PARTNERSHIPS

ASIA

The BROCAP® trap in Indonesia: A commercial success

As a result of the work done by CIRAD and its partners in Indonesia, supported by marketing operations on the part of IndoCafCo, 92 000 BROCAP traps and 360 000 attractant units were sold to the Indonesian government.

CIRAD's expertise on coffee berry borer control has been demonstrated in Central America, especially with the creation of this trap, the definition of a trapping strategy, the industrial manufacturing of BROCAP and its marketing.

In North Sumatra, where the coffee berry borer causes 70% of yield losses, a partnership between CIRAD, IndoCafCo and ICCRI, assisted by the Institut Français d'Indonésie (IFI - French Institute of Indonesia), was established in 2012 to study the situation. The first findings show that trapping has an important role to play in this control, as part of an integrated strategy.



Research conducted by CIRAD, IndoCafCo and CVT Valorisation Sud (theme-based technology transfer consortium for progress in the countries of the South) helped to improve the trap.

<http://www.cirad.fr/innovation-expertise/produits-et-services/equipements-et-procedes/brocap-r>

The BROCAP® coffee berry borer trap, selected as one of the three best innovations for Indonesian coffee producers, received the Special Jury Prize at the Coffee Finance Fair, held in Bandar Lampung from 25 to 27 August.

Agreements

In Indonesia, the five-year extension of the research framework agreement with the Indonesian Agency for Agricultural Research and Development (IAARD) created the conditions for assigning a researcher from the Qualisud joint research unit to the Indonesian Centre for Agricultural Post Harvest Research and Development (ICAPRD) in Bogor, within the framework of a joint research project on the quality of starch-based food resources (cassava, plantain).

In Vietnam, the agreement between the partners of the project on "Support for the development of geographical indications in Vietnam", supported by AFD, was signed at the National Office of Intellectual Property (NOIP) in Hanoi on 14 April by CIRAD, the Rural Development Centre (RUDEC) and the Center for Agrarian Systems Research and Development (CASRAD), in the presence of the Deputy Minister of Science and Technology (MOST).

In Indonesia, a Memorandum of Understanding was signed with the **Muhammadiyah University of Purwokerto (Java)** during the university's 50th anniversary celebrations on 21 April.

Event

The MYCODIPT project closing seminar took place from 13 to 15 October at the Forest Research Institute of Malaysia (FRIM). The findings of this project on mycorrhizal fungi in Dipterocarp forests will help to better integrate soil microbiology and its management into reforestation programmes for degraded land and logged forests. This project is supported by Bio Asia and the French Ministry of Foreign Affairs and International Development.

Alain Rival, Jakarta, Indonesia,
Regional Director for Southeast Asian Island Countries

Philippe Girard, Hanoi, Vietnam,
Regional Director for Continental Southeast Asia

New agroecology projects

Accompanying the agroecological transition in Southeast Asia - ACTAE, 2015-2018, French Development Agency (AFD - French development agency) [Cambodia - Laos - Myanmar - Vietnam]

The goal of ACTAE is to increase the credibility and visibility of agroecological practices among family farmers, consumers and policy makers. It provides support for CIRAD's CANSEA network and for the emerging ALiSEA network managed by GRET.

<http://cansea.org.vn>

<http://ali-sea.org>

Developing climate resilient agricultural systems in Laos - EFICAS, AFD [Northern Uplands Development Programme, NUDP], European Union [Global Climate Change Alliance Programme, GCCAP].

The goal of EFICAS is to develop innovative approaches in the mountain provinces of Northern Laos in order to accelerate the adoption by farmers of climate-smart farming systems based on conservation agriculture. The land management department of the Laos Ministry of Agriculture and Forests is implementing the project together with CIRAD.

<http://www.eficas-laos.net>

Developing educational resources on conservation agriculture in Cambodia - IPERCA, 2015-2017, CIRAD

IPERCA is based at the Ecoland centre at the Royal University of Agriculture in Phnom Penh, and benefits from initiatives conducted by the Conservation Agriculture Service Centre (CASC). Five modules will be developed, ranging from the underlying principles of agroecology to the adoption of innovations and agricultural change.

SCIENTIFIC ACTIVITIES

“Innovation-impact”

Thirteen case studies to test the ImpresS method

A fundamental element of the “Innovation-Impact” project, the ImpresS methodological approach developed by CIRAD aims to explore innovations and their impact pathways. Nine students and four researchers presented the first outcomes of the ImpresS method (IMPact of RESearch in the South) through 13 case studies, on 4 September in Montpellier.

This is the second phase of the cross-cutting “Innovation-Impact” process launched in January 2014 for a four-year period with the goal of developing the impact culture at CIRAD: it is not enough to ask the right research questions and to answer them using excellent science to contribute to development; it is also important to establish the way in which the knowledge produced fits into innovation processes within societies, in close connection with socioeconomic actors and public policy makers. By adopting this approach, CIRAD is joining other research organisations such as the CGIAR centres, INRA and the European IMPRESA project.

The ImpresS method

The ImpresS method is based on the active participation of key players in innovation: researchers, farmers, producer organisations, etc. Faced with complex multi-stakeholder and multi-causal issues and environments, it builds on 13 case studies to produce quantitative and qualitative indicators and to analyse the contribution of research to impact. CIRAD has chosen to develop this analysis in two fields that receive little attention in other approaches: capacity building for the different stakeholders and impacts on public policies.

In February 2015, the method was refined and the case studies were launched during a series of workshops with all case study coordinators, their partners from the countries of the South, Masters degree interns and impact assessment practitioners (INRA, the Research Institute of Organic Agriculture - FiBL). The initial findings were made public as of September. CIRAD finally presented the method and case studies during the international conference on “Impacts of agricultural research - an approach of societal values”, on 3 and 4 November in Paris.

These case studies have been underway since March 2015 in their different areas, supported by a methodological group made up of researchers from different units and, in particular, from the Innovation joint research unit. Ten Masters students and a post-doctoral student were recruited to contribute to the project. Their findings will be analysed during a series of workshops in spring 2016 with a view to identifying cross-cutting lessons and thereby improving CIRAD’s research activities in order to increase their impact.

Danielle Barret, Montpellier, France - Etienne Hainzelin, Gatineau, Canada
Coordinators of the Innovation-Impact project



Sugarcane white grub in the soil © R. Goebel/CIRAD

The 13 case studies

Brazil (Santa Catarina state)

- > Geographical indications and promotion of family farm products.

Burkina Faso

- > Manure management in agro-pastoral systems.
- > Sorghum breeding.

Burkina Faso/Mali

- > Fonio huller/whitener.

Dominican Republic

- > Brocap®, Coffee berry borer trap.

France

- > Pl@ntnet, a plant identification platform.

Indonesia

- > Integrated water management.

Madagascar

- > Rainfed upland rice.

Réunion

- > Organic residue recycling.
- > White grub control.

Senegal

- > Groundnut breeding and seed production.
- > Tsetse fly eradication.

Vietnam

- > Animal health surveillance.

<http://impres-impact-recherche.cirad.fr>

Food security

GloFoodS: 28 projects supported by CIRAD and INRA

The first call for expressions of interest for the meta-programme “Transitions to global food security”, GloFoodS, extensively mobilised the scientific community: 28 interdisciplinary projects were selected and launched in 2015, most of which involve teams from CIRAD and INRA, and sometimes from other institutions. These projects address four key research questions.

- > How does food security governance affect farming practices and land use?
- > How do dietary transitions – how we eat – affect the equation between food requirements, farming practices and land use?
- > How do changes in agricultural practices and production systems affect dietary transitions and household access to food?
- > How do agricultural production practices affect the efficiency and sustainability of agri-food processes, especially in terms of losses and waste?

These projects are conducted in France, but also in other parts of the world, in Brazil, India, Vietnam, Senegal, Ghana and Cameroon, among others.

The goal of GloFoodS is to explore innovative ways of building bridges between the analysis of food availability, which has long been the focus of research, and the other “pillars” of food security, access, use and stability. It combines global and local approaches in order to compare regional adaptations of global scenarios with dynamics observed at a more local.

Etienne Hainzelin, Gatineau, Canada
CIRAD GloFoodS Coordinator

GloFoodS is an incentive tool aimed at supporting interdisciplinary dynamics, catalysing new ideas and accompanying the development of ambitious projects according to the thematic and strategic priorities CIRAD and INRA have jointly set themselves. In particular, it is based on the Agrimonde and DuaLine studies conducted previously, and on the Agrimonde-Terra prospective study underway, which examines the relationships between food security and land use.



Periurban market gardening in Senegal (Nyayes)
P. Dugué © CIRAD

SCIENTIFIC ACTIVITIES

<https://agritrop.cirad.fr/>



AGRITROP is now CIRAD's open archive for publications

CIRAD's publications database, Agritrop, created in 1986, is now an institutional open archive. Its new version gives CIRAD's publications greater visibility, particularly co-publications between CIRAD and its partners in the South on agricultural research and rural development. CIRAD is thus reaffirming its commitment to the global drive to achieve open access to knowledge in the sciences and humanities.

Marie-Claude Deboin, Scientific and Technical Information Officer

93 000 references

25 000 full-text documents

14 000 of which are available online

New Masters, new MOOCs

A number of conventions link CIRAD to higher education establishments in the countries of both the North and the South, and this activity occupies almost 10% of the researchers' working time. CIRAD has been producing distance learning modules on its own platform since 2008. Since 2010, it has been one of the very active founders of the Université Virtuelle Environnement et Développement Durable (UVED - virtual university for environment and sustainable development), and has been accompanying the emergence of the AGREENIUM University On Line (AUOL) since 2014. It also offers a catalogue of more than 70 professional training modules.

New Masters courses

"Etude du développement (EDEV - Development studies)" (Art-Dev, Innovation, UM3, UPVD): Development dynamics, practices and policies in the countries of the South.

"Economie du développement agricole, de l'environnement et alimentation (ECODEVA - Economics of agricultural development, environment and food)" (Montpellier SupAgro, CIRAD, UM, IAMM)

New MOOCs

"Agro-écologie (Agroecology)", coordinated by Agreenium (French institute for agricultural, forestry, and veterinary Sciences)

"Energies renouvelables (Renewable energies)", coordinated and produced by UVED and supported by ADEME, prepared with the University of Perpignan Via Domitia and 32 experts from 15 different establishments, including CIRAD

"Biodiversité (Biodiversity)", produced and coordinated by UVED.

Find out more: <http://www.cirad.fr/en/teaching-training>

Perspective

Perspective is a series of policy briefs launched by CIRAD to fuel the debate, change ideas and support decision-making. *Perspective* is provided according to the terms of the Creative Commons Licence.

No 31. Urban agriculture support policies in West Africa. Taking account of informal arrangements. Ophélie Robineau

In the towns and cities of Africa, crop and livestock farmers and waste management services often reach informal agreements in order to conduct their activities. Policy-makers must take these agreements into account.

Available in French and English

No 32. Investments in "smallholder" family farming. Towards a new deal. Pierre-Marie Bosc

Integrated public policies are needed to ensure smallholder farmers are able to invest in their farms. Their primary goal should be reducing the weight of expenditure on families and the time

devoted to some household chores, with a view to freeing their capacity for initiative.

Available in French, English and Spanish.

No 33. Participatory development of collective rules for natural resource and land management. Lasting effects from the local to the national level. Patrick d'Aquino

Aimed at stakeholder independence, Self Land Policies, a methodology for participatory simulation, is producing long-term impacts.

Available in French, English and Portuguese.

No 34. Integrated management of insect vectors of human and animal diseases. Developing genetic control. Jérémie Bouyer

Faced with pressure from insect vectors of disease and insecticide resistance, genetic control is emerging as a key alternative.

Available in French and English.

No 35. Control of endemic tropical diseases. Identifying certain animal diseases as "neglected". François Roger, Pascal Bonnet

To mobilise stakeholders and donors, animal diseases that maintain poverty should be identified as "neglected".

Available in French and English.

No 36. Major food companies, PES and combating deforestation. Using PES to achieve "zero deforestation" agriculture. Alain Karsenty

Payments for environmental services can make the zero deforestation approaches adopted by the major companies more effective.

Available in French and English.

<http://www.cirad.fr/en/publications-resources/publishing/perspective-policy-brief>

FOCUS

on the year of
climate
change

See our full report
on climate change
www.cirad.fr





Emmanuel Torquebiau on the stand at the 2015 Paris International Agricultural show
© M. Adell/CIRAD

Focus on the year of Climate change

Emmanuel Torquebiau, an ecologist and Climate Change Correspondent at CIRAD, coordinated operations at CIRAD in preparation for COP21.

He sums up the past year below.

The holding of the UN Conference of the Parties on Climate Change (COP21) in Paris in December put France at the forefront of climate change talks. CIRAD was heavily involved in this national drive. How did it prepare for the event?

Emmanuel Torquebiau: First of all, we did a stocktake in 2013 of all CIRAD's research relating to climate change, followed by an internal debate in 2014. This enabled our researchers to take a fresh look at their work, fuelled the scientific debate and opened up new perspectives. It resulted in the publication of a book, *"Climate Change and Agriculture Worldwide"*, in collaboration with the Agence française de développement (AFD). The French version was presented at the Paris International Agricultural Show in February and the English version at COP21. 1500 copies have been distributed in French and 500 in English.

For the Paris International Agricultural Show in February, we had a 200-m² joint stand with the AFD on "Agriculture and the climate challenge". The show is a major opportunity to meet the general public and above all our partners from all over the world. CIRAD worked with the AFD on the "Climate Challenge, Agriculture and Forestry" contest, with the winners receiving their awards on the stand, in the presence of Anne Paugam, Director of the AFD, and CIRAD President Managing Director Michel Eddi.

CIRAD, along with INRA, the IRD, Agropolis International and international partners, organized the "Climate-Smart Agriculture" conference from 15 to 17 March, in Montpellier. The conference was attended by 750 researchers from more than 70 countries, who were able to discuss the agronomic options available with a view to adapting to and mitigating climate change, and to guaranteeing food security. For the first time, it brought together specialists in both climate and agronomy. Stéphane Le Foll, the French Minister of Agriculture, attended, and during his speech, he mentioned the "4 per 1000" hypothesis, which has become a French initiative with an international scope.

Climate-Smart Agriculture 2015

The 3rd Global Science Conference on Climate-Smart Agriculture was held in Montpellier, from 16 to 18 March 2015. It was organized by CIRAD, INRA, IRD and Agropolis International. For the first time, the conference brought together specialists in both climate and agronomy, to tackle a triple challenge:

- > sustainably increasing agricultural productivity and farmers' incomes so as to achieve national food security and development objectives;
- > boosting the resilience of farming and food systems and their adaptation to climate change;
- > mitigating greenhouse gas emissions and promoting carbon sequestration.

The conference culminated in the "Montpellier Declaration".



Changement climatique et agricultures du monde. E. Torquebiau (Coord). Ed. Quae, 2015

This book, the third in the "Agricultures et Défis du Monde" series co-published with the AFD, takes stock of work by CIRAD, the AFD and their partners. It covers the burning issues surrounding the role and place of tropical farming systems in climate change: impact, adaptation, mitigation. There are many uncertainties and questions, but there are also solutions, as varied as new agronomic practices, agricultural waste recycling, or payments for ecosystem services. Several chapters are devoted to public policy and to support of the transformations required. Innovative pathways are suggested for the farming systems of the future in all these countries, along with a critical look at the main manoeuvres under way and what this all means for research.

English version: *Climate Change and Agriculture Worldwide* Editor E. Torquebiau. Springer, 2015

"4 per 1000" is the annual increase in soil carbon levels required to offset greenhouse gas emissions.

Lastly, CIRAD organized a meeting with European Commission policymakers in Brussels on 19 November, to present its approach and its work on climate change.

How have CIRAD staff members been associated with these operations?

E. T.: The whole of CIRAD has been involved: internally, a photography competition helped us gather new pictures. Our researchers worked to prepare the stand for the Paris International Agricultural Show, where they welcomed the public and took part in debates and round tables. Throughout the year, they participated in international scientific conferences, organized meetings with policymakers and talked to the general public at a range of events in France, the French overseas regions and abroad. A travelling exhibit did the rounds of our regional offices. Many of our researchers were also in Le Bourget and at the Grand Palais in Paris, for COP21. All these events received substantial media coverage, and CIRAD was widely quoted.

COP21 resulted in a historic agreement between all parties... What pointers does this give CIRAD for planning future operations?

E. T.: The COP21 agreement will serve as the basis for all future initiatives concerning climate change. In many respects, developing countries are on the front line of this agreement. In effect, it specifies that all countries must participate in fighting climate change, whereas the Kyoto protocol was primarily concerned with mitigation and only required a commitment on the part of developed countries. The Paris agreement recognizes that for developing countries, adaptation is still a priority, but it stresses the synergies that exist between adaptation and mitigation and the role those countries can play. It also insists on the urgent need to satisfy the immediate needs of those countries, which it considers to be "particularly vulnerable to the adverse effects of climate change". Moreover, it states that programmes should be conducted "in the context of sustainable development and efforts to alleviate poverty".

CIRAD's work on soil carbon, agro-ecology, forests, sustainable development and food security is therefore particularly relevant. The "4 per 1000" initiative is a step in the right direction.

"The COP21 agreement will serve as the basis for all future initiatives concerning climate change."

"Our Common Future under Climate Change"

Organized ahead of COP21, in Paris from 7 to 10 July, with the support of the French government and under the aegis of the International Council for Science (ICSU), Future Earth, UNESCO and the main French scientific organizations, including CIRAD. This was the largest meeting of the scientific community ahead of COP21: almost 2000 scientists from all over the world. CIRAD intervened in five events at the conference: four parallel sessions and a side event.

2015 Paris Climate Conference, COP21

From 30 November to 12 December 2015. The United Nations Conference on Climate Change, or COP21, was an unprecedented event both for France and on a global level, with some 42 000

visitors and 350 talks and debates. More than 20 experts from CIRAD contributed to various round tables, debates and interviews, notably on forests, agro-ecology, and payments for environmental services, with the aim of promoting agricultural research with regard to climate change and of pooling resources to work on key operations in partnership with southern countries.

CIRAD was a member of the delegation taking part in the official launch on 1 December of the "4 per 1000" initiative by Stéphane Le Foll and co-organizer of a side event on the initiative and, with the IRD, of a day of scientific meetings in Bondy, open to all research partners (NGOs, professional organizations, communities, development staff, etc). CIRAD was also in the Grand Palais, alongside all the other French research organizations, to present its results within an exhibition, "Solutions COP 21".

Climate and food security The "4 per 1000" programme puts soils back at the heart of agriculture



"It is vitally important to increase carbon capture in soils". This is the message behind the "4 per 1000" programme announced in March 2015 by French Minister of Agriculture Stéphane Le Foll at the "Climate-Smart Agriculture" conference. The 4 per 1000 concept promises to mitigate climate change by increasing carbon capture by soils, and also has a second objective, of major importance for people in southern countries: that of also helping boost global food security.

Numerous international research organizations expressed an interest in this French initiative, at a meeting at CIRAD Head Office in Paris on 30 November, during COP21, organized by the four members heading the research component (CIRAD, CGIAR, INRA and IRD). Those organizations include Wageningen University, the Chinese Academy of Agricultural Sciences (CAAS), the Forum for Agricultural research in Africa (FARA), the Global Forum on Agricultural Research (GFOR), and the Global Research Alliance on Agricultural Greenhouse Gases (GRA).

Hervé Saint Macary, Deputy Director of CIRAD's PERSYST Department, is the project coordinator for CIRAD.

Many of CIRAD's research fields are concerned by climate change.

The aim is to determine and design the many innovations required to help change habits, for instance:

- Modelling plant responses to climate constraints
- Ensuring sustainable water management
- Breeding plants suited to high temperatures, salinity or water shortages
- Fostering ecosystem services that have a positive effect on greenhouse gas emissions
- Working on the synergy between adaptation to and mitigation of climate change
- Drafting new public policies
- Analysing the issues surrounding global climate talks
- Devising new economic instruments
- Designing "carbon-rich" cropping systems, crop associations, farms and landscapes
- Imagining highly environmentally efficient livestock production systems
- Rethinking local energy production so as to cut fossil fuel use
- Integrating the notion of standards and certification into production strategies
- Boosting agricultural by-product recycling
- Understanding the links between climate change and animal or plant health.

How might agro-ecology be a valid option in response to climate change?

This was the question asked at a Franco-Chinese conference organized by the French Embassy in Beijing from 3 to 5 June, in which CIRAD, INRA and the French Ministry of Agriculture were actively involved, in preparation for COP21. During the conference and under the aegis of the French Embassy in Beijing, CIRAD signed a general agreement with the Chinese Academy of Tropical Agricultural Sciences [Catas].

Etienne Hainzelin, Gatineau, Canada, Adviser to the CIRAD President Managing Director

Publications

Mémento du forestier tropical. D. Louppe, G. Mille (Coord). Ed. Quae, 2015. The Mémento du forestier tropical is a unique book, written by more than a hundred authors. It is a compilation of the knowledge and skills required for sustainable management of tropical forests, from shrubby savannah to dense forest, and from agroforestry to industrial plantations. It also covers optimum use of fuelwood and timber, non-wood forest products, and wildlife. It addresses the main environmental issues in a context of global change and globalization. It provides the keys to understanding ecological functioning and the political, economic and social contexts that must be combined in order to ensure the permanence of the products and services provided by tropical forests for the beneficiaries of today and tomorrow.

Les enjeux de la conférence de Paris. Penser autrement la question climatique. A special issue of *Natures Sciences Sociétés*, a journal co-published by CIRAD, to mark COP21. The articles (on open access) suggest various possible ways of overcoming the climate change issue, by putting the latest research to good use.
<http://www.nss-journal.org/fr/articles/nss/abs/2015/02/contents/contents.html>

Climate-smart agriculture for food security. Lipper L., Thornton P., Campbell B.M., Baedeker T., Braimoh A., Bwalya M., Caron P., Cattaneo A., Garrity D.P., Henry K., Hottle R., Jackson L., Jarvis A., Kossam F., Mann W., McCarthy N., Meybeck A., Neufeldt H., Remington T., Sen P.T., Sessa R., Shula R., Tibu A., Torquebiau E. 2014. *Nature Climate Change*, 4: p. 1068-1072.

L'avenir des forêts ? Comprendre vite et mieux. S. Guéneau, I. Biagiotti. InfoGraphie collection. Belin - Cité des sciences et de l'industrie co-publication, 2015.

60 research success stories for a sustainable planet. To mark COP21, the 28 AllEnvi member organizations published a compilation of 60 success stories.

Special issue of the journal Agronomie, Environnement et Sociétés, vol. 5, no. 1: Changement climatique et agriculture: comprendre et anticiper, ici et ailleurs. Benoit M. and Torquebiau, E., coordinators, 2015.

Climate change: impact and adaptation - Les dossiers d'Agropolis International - No. 20, February 2015.

Events

2-5 June: Agro-ecology and climate change seminar in Beijing (Chinese Academy of Agricultural Sciences - CAAS, INRA, CIRAD); during the event, CIRAD signed a general agreement with the Chinese Academy of Tropical Agricultural Sciences [CATAS].

7-12 September: World Forestry Congress in Durban (South Africa): three parallel sessions were organized by CIRAD.

17-18 September: Vector control in the light of climate change in Maisons-Alfort (ANSES, CIRAD, CNCV, INRA).

11-16 October: Water and climate change (International Commission on Irrigation and Drainage - ICID, Association française pour l'eau, l'irrigation et le drainage - AFEID, of which CIRAD is a member), in Montpellier.

4-11 December: an event for the general public on climate research, Grand Palais, Paris.

Wadi in spate threatening a traditional track in southern Tunisia O. Chartron © CIRAD



Tropical forests are more vulnerable to climate change than expected

Interview with Ghislain Vieilledent, an ecology and applied statistics researcher at CIRAD

According to a recent study by CIRAD in Madagascar, climate change will reduce the capacity of tropical forests to capture carbon dioxide (CO₂) from the atmosphere. Even worse, those forests could become CO₂ emitters, causing climate change to snowball! This is another reason to slow deforestation and reduce greenhouse gas emissions.

What did your study show?

Ghislain Vieilledent: According to our model, climate modifications due to warming [increased temperatures, reduced rainfall and a shorter growing season] could result in a 17% fall in forest carbon reserves by 2080 [some forecasts go up to as much as 24%]. Future climate changes look set to favour smaller trees and other species, which by definition capture less carbon. Our study also identified tipping points: above an annual average of 21°C and below 1100 mm of rainfall per year, carbon reserves in tropical forests could collapse.

We conducted our research in Madagascar, where captured carbon was measured in

more than 1700 plots and inputted into a "bioclimatic envelope" model. Grande Île was ideal for this exercise, since it has a wide range of climates.

You used an innovative model to assess the impact of climate change on tropical forests. Why?

G.V.: Although conventional climate and vegetation dynamics models are very useful, they have certain weaknesses. For instance, they do not take account of changes in the species makeup of forests as a result of climate change. But above all, such models assume that CO₂ has a fertilizing effect. At greater concentrations in the atmosphere, CO₂ is supposed to result in greater plant

growth, hence in increased carbon capture. This fertilizing effect is increasingly controversial. By discussing the basic hypotheses, this study suggests possible ways of improving the models most commonly used, notably by the IPCC*, to forecast the climate.

Were you expecting these figures?

G.V.: We were expecting forest carbon capture to fall as a result of climate, but not to that extent! The link between climate and carbon reserves is now both obvious and easy to interpret. Rainforest species should gradually be replaced by others that are better suited to the new climate conditions. On a scale of 100 years, forests should become sparser, trees smaller and foliage less dense. Unfortunately, this is the optimistic scenario.

According to you, forests could even become CO₂ emitters!

G.V.: Yes. The shift from dense forest to sparser forest will be made provided that species suited to the new climate conditions can spread. However, the environment is not propitious: the forests are fragmented, the soils are eroded and those animals that spread seeds are becoming increasingly rare. In an increasingly hot, dry world, there is a risk, in the long term, that the rainforests we know today may eventually look more like wooded savannah. When you think that tropical forests store almost 40% of the world's terrestrial carbon, it is obviously vital to do all we can to preserve them, and also to cut greenhouse gas emissions as quickly as possible!

* Intergovernmental Panel on Climate Change

Ghislain Vieilledent, ISPRA, Italy, Forests and Societies (F&S)

Vieilledent G. *et al.* [2016] « Bioclimatic envelope models predict a decrease in tropical forest carbon stocks with climate change in Madagascar », *Journal of Ecology*, DOI : 10.1111/1365-2745.12548



Research Results

AMAZON FORESTS AND CARBON

20 years to recover their stock

Erwan Rutishauser, Montpellier, France, Forests and Societies (F&S)

A recent study conducted within the framework of the Tropical managed Forests Observatory (TmFO) revealed that Amazon forests logged with reduced impact logging techniques recover their initial carbon stock in 7 to 21 years. This result proves that sustainably logged tropical forests play a key role in global carbon capture, hence in mitigating climate change. It also showed that the cutting cycle of 20 to 30 years imposed by forestry laws in Amazonia, alongside selective logging, is sufficient for carbon stocks to recover.

Rapid tree carbon stock recovery in managed Amazonian forests. *Current Biology*, 25: R787-R788. Doi: 10.1016/j.cub.2015.07.034

Limited capture capacity

Bruno Hérault, Kourou, French Guiana, Ecology of Guianan Forests (ECOFOG)

The Amazon is losing its capacity to capture atmospheric carbon. This was revealed by a major inventory over thirty years in the forests of Ama-



zonias. The study was the most comprehensive ever conducted of this issue to date, and involved around a hundred researchers, including a large number from France (CIRAD, the CNRS and INRA). In past decades, the Amazon rainforest acted as an atmospheric carbon sink, capturing more carbon than it emitted and helping to reduce the impact of global warming. However, a recent analysis of forest dynamics revealed a rapid increase in the tree mortality rate, of more than a third since the mid-1980s, which has affected the forest's capacity to capture carbon. This change in regime could have unexpected consequences and may cast doubt on the assumption that tropical forests have an infinite capacity to capture carbon.

Long-term decline of the Amazon carbon sink. *Nature*, 519: 344-348. Doi: 10.1038/nature14283

The Amazon rainforest contains a fifth of all known species on Earth, including more than 15 000 tree species. Its 300 billion trees store a fifth of the carbon in the Earth's terrestrial biomass © S. Fauset

1% of their tree species account for half their carbon stock

Bruno Hérault, Kourou, French Guiana, Ecology of Guianan Forests (ECOFOG)

Amazon rainforests are the world's most extensive and are extraordinarily diverse, being home to an estimated 16 000 tree species. Yet just two hundred of those species, barely 1%, are responsible for half of all tree growth and carbon stored in the Amazon, according to a study by the Rainfor network, involving several CIRAD researchers. Using a vast dataset, the researchers were able to compare the abundance, biomass stock and woody growth of 3600 tree species, which showed that it was not the most abundant species in the Amazon that stored the most carbon. On the contrary, some rare species, such as *Bertholletia excelsa*, were among the highest ranking species in terms of carbon storage and wood production. The biodiversity of the Amazon rainforest in fact comprises numerous small tree species in the understorey, which store little carbon.

Hyperdominance in Amazonian forest carbon cycling. *Nature Communications*, 6: no 6857. Doi: 10.1038/ncomms7857

ADAPTATION AND MITIGATION

Two complementary strategies in response to climate change

Bruno Locatelli, Lima, Peru, Forests and Societies (F&S)

Adaptation and mitigation both set out to fight climate change, but by different means: the former tackles the consequences, by reducing social and ecological vulnerability, while the latter addresses the causes, by reducing greenhouse gas emissions. The two strategies are complementary, and projects would be well advised to combine the two in order to boost their efficacy and above all to avoid inconsistencies and conflict. This is the conclusion reached by CIRAD researchers and their partners, who have analysed several climate change remediation projects in the fields of agriculture and forestry. That said, the authors consider that there is no question of forcing people to combine the two approaches in every project and every policy. Project designers and policy-makers must have good reasons to do so, but above all, they must be aware that it is possible to do so without disrupting the project design process and increasing costs.



Protecting watersheds can reduce the impact of climate change
© B. Locatelli/CIRAD

PARTNERS. Center for International Forestry Research (CIFOR, Indonesia). Swiss Institute of Technology Zürich (ETH, Switzerland). UNEP DTU Partnership on Energy, Environment and Sustainable Development (Denmark). University of Leeds (UK).

Addressing climate change mitigation and adaptation together: a global assessment of agriculture and forestry projects. *Environmental Management*, 12 p. Doi: 10.1007/s00267-015-0605-y

Integrating climate change mitigation and adaptation in agriculture and forestry: Opportunities and tradeoffs. *Wiley Interdisciplinary Reviews: Climate Change*, 6: 585-598. Doi: 10.1002/wcc.357

Synergies between adaptation and mitigation in climate change finance. *International Journal of Climate Change Strategies and Management*, 8: 19 p. Doi: 10.1108/IJCCSM-07-2014-0088

TROPICAL FORESTS

Models for forecasting the changes in plant stands

Frédéric Mortier, Montpellier, France,
Forests and Societies (F&S)

How do environmental factors, climate change and human activities change the dynamics of tropical forests? This question is vital for the conservation of such ecosystems against a backdrop of global change. Reliable, precise tools have yet to be developed. CIRAD recently designed a class of novel, innovative models that reproduce the dynamics of tropical forest stands as a whole and their diversity. These easy-to-use tools serve to analyse and anticipate forest evolution in the face of change. The models were tested on data gathered at the M'Baïki experimental site in the Central African Republic, which comprises 40 hectares of permanent plots, either logged or not. These novel, innovative models have a wide range of applications. They can be used to analyse the viability of populations and manage natural populations, or to understand and quantify the impacts of climate change and forestry activities on the future of tropical forests. They are also excellent tools for simulating and designing sustainable forest management solutions.

PARTNERS. AgroParisTech (France). Georgetown University (USA). Ministry of Waters, Forests, Hunting and Fishing (Central African Republic)

Mixture of inhomogeneous matrix models for species-rich ecosystems. *Environmetrics*, 26: 39-51. Doi: 10.1002/env.2320



Gap in the forest canopy left by a fallen tree
© S. Gourlet-Fleury/CIRAD

CENTRAL AFRICAN FORESTS

Large trees are best at storing carbon

Sylvie Gourlet-Fleury, Montpellier, France,
Forests and Societies (F&S)

In Central Africa, large trees and a few hyperdominant species play a prominent role in carbon storage and forest structure. These findings, obtained by means of a vast survey by CIRAD scientists working with many other researchers

from both North and South, fill the gaps in our knowledge of these forests, which are a major issue for the countries in the region. In more concrete terms, they have given rise to new methods for estimating carbon stocks that are both simple and economical. Using the models they designed, the researchers showed that it was possible to establish the carbon balance of the entire forest stand by measuring just 5% of its individuals, with a margin of error of less than 15%. This result was particularly important for current climate change research: carbon stock in dense forests can now be assessed much more easily and more cheaply.

Seeing Central African forests through their largest trees. *Scientific Reports*, 5: 13156. Doi: 10.1038/srep13156

A sapele tree (*Entandrophragma cylindricum*)
in Cameroon © S. Gourlet-Fleury/CIRAD



A word from one of our partners

“Scientific networks: a very rewarding way of sharing experiences, approaches and concepts”

Professor Marcel Bursztyn is a socioeconomist. He has been working with CIRAD for more than 20 years, on topics relating to public environment and territorial development policy. After directing the Centre for Sustainable Development, he is now Director of Research at the University of Brasília. He is also coordinator of the Brazilian climate network, a sort of national IPCC*.

What are the main advantages of working in a network?

Marcel Bursztyn: It provides access to three levels of scope: interdisciplinary, global and inter-institutional operations. These multiple dimensions are crucial for us, since we are working on topics — public sustainable development policy — that are

seen differently depending on the players, disciplines and geographical zones involved. This sharing of experiences, approaches and perspectives is extraordinarily rewarding. It can really be seen as cooperative research.

You are involved in a platform in partnership for research and training, Public Policy and Rural Development in Latin America (PP-AL)...

M.B.: Yes, and I recently attended a meeting of the platform to present the Brazilian climate network. I was pleasantly surprised by the very strong commitment of all the researchers present. A network is easy to set up, but much more difficult to sustain and run. However, I felt that there was significant intellectual complicity and consistency of perspective as regards those research topics that find themselves at the crossroads between public

policy and family farming in various national contexts. I was also impressed by the quality of their results, primarily obtained through field work.

Do you have any plans for your two scientific networks to work together?

M.B.: When I presented the climate network to researchers from the PP-AL platform, we realized that we had a lot of things in common. By extension, the climate network is studying the effects of global warming on family farms. We are beginning to see that vulnerability to climate change is growing, due to that change, which is a worrying snowball effect. Associating our two networks to allow sharing of experiences, data and methodologies can only be a good thing.

* Intergovernmental Panel on Climate Change

Research Results 2015 (a selection) >

Pasture captures carbon
(French Guiana, 2011)
V. Blanfort © CIRAD



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tab > Research operations
heading > Research Topics

ECOLOGICALLY INTENSIVE AGRICULTURE

Inventing sustainable farming systems that make optimum use of agro-ecosystems

RUBBER

A core collection to preserve rubber genetic resources

Vincent Le Guen, Montpellier, France, Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (AGAP)

Researchers from CIRAD and their Brazilian colleagues recently characterized more than 1000 *Hevea* accessions held in Brazil and French Guiana, using molecular markers. This enabled them to compile a core collection of around a hundred trees, which encompasses the entirety of the genetic diversity described with the markers used and will facilitate the conservation of rubber genetic resources. That conservation is vital at a time when deforestation is resulting in unprecedented impoverishment of those resources in Amazonia.

PARTNERS. Agência Paulista de Tecnologia dos Agronegócios (APTA, Brazil); EMBRAPA Cerrados (Brazil); Instituto Agrônomo (IAC, Brazil); Universidade Estadual de Campinas (Unicamp, Brazil); Universidade Estadual do Sudoeste da Bahia (UESB, Brazil); Universidade Estadual Paulista (Brazil).

Genetic diversity strategy for the management and use of rubber genetic resources: more than 1,000 wild and cultivated accessions in a 100-genotype core collection. *PloS One*, 10: e0134607 [20 p.]. Doi: 10.1371/journal.pone.0134607

Sampling rubber tree leaves from a collection plot
© C.C. Silva/CIRAD



OIL PALM

A step towards marker-assisted breeding

Sébastien Tisné, Montpellier, France, Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (AGAP)

Marker-assisted breeding has not been extensively studied for oil palm due to the cumbersome nature of the genetic techniques required to implement it. To overcome this difficulty, researchers from CIRAD have suggested using data obtained from improvement programmes, during which numerous tests are carried out on progenies for parents whose pedigree is known. This approach has proved particularly good at identifying QTL of use in breeding and could be extended to other species liable to the same problems as oil palm. The approach is novel in that it adapts methods used in human and animal research, based on knowledge of pedigrees over several generations.

PARTNERS. Institut national des recherches agricoles du Bénin (INRAB, Benin); PT Socfindo (Indonesia); PalmElit SAS (France)

Pedigree-based linkage map in two genetic groups of oil palm. *Tree Genetics and Genomes*, 11: 68 [12 p.]. Doi: 10.1007/s11295-015-0893-7



Plot in the Aek Loba genetic block, North Sumatra, Indonesia © M. Denis/CIRAD

Mixed model approach for IBD-based QTL mapping in a complex oil palm pedigree. *BMC genomics*, 16: 798. Doi: 10.1186/s12864-015-1985-3

COCOA SURVEYS IN FRENCH GUIANA

New genotypes for genetic improvement

Philippe Lachenaud, Montpellier, France, Pests and Diseases: Risk Analysis and Control (Bioagresseurs)

A survey on the banks of the Tanpok and its tributaries, in French Guiana, served to identify four cocoa populations, two of them new. A genetic study placed them in the Guiana group, an original group of particular interest in the fight against pests. The genotypes collected have been added to the cocoa collection held by CIRAD in French Guiana. After describing the material collected, the researchers analysed its genetic diversity using microsatellite markers. This confirmed that the genotypes collected indeed belonged to the Guiana group, but failed to reveal any specificities. The seeds obtained from the pods collected were sown and the resulting seedlings planted in January 2013 in Sinnamary, as part of the CIRAD cocoa collection.

Cacao trees (*Theobroma cacao* L.) of the Guiana genetic group: Tanpok 2012 survey. *Genetic Resources and Crop Evolution*, 10 p. Doi: 10.1007/s10722-015-0280-0

The delight of the expedition guide after the discovery of wild cocoa trees
© P. Fresquet/CIRAD



INTENSIFYING PLANTED FORESTS

Nitrogen-fixing species

Jean-Pierre Bouillet, Piracicaba, Brazil, Functional Ecology and Bio-geochemistry of Soils and Agro-ecosystems (Eco&Sols)

How can we satisfy growing demand for wood while the areas available for production are shrinking? By intensifying the productivity of planted forests in a sustainable way, using nitrogen-fixing species. This was the idea behind a research project coordinated by CIRAD. The project was conducted in France, Congo and Brazil, and set out to determine how introducing nitrogen-fixing species modified the biological functioning of planted forests. The researchers took a series of measurements to quantify the biophysical interactions between species. Using those data, they developed models that reproduce mixed planting functioning and growth. The results, supplemented by a socioeconomic analysis, have made it possible to suggest innovative forest management systems capable of meeting stakeholders' needs.

PARTNERS. Association française d'agroforesterie (AFAF, France); Centre de recherches sur la durabilité de la production des plantations industrielles (CRDPI, Republic of Congo); Institut de recherche pour le développement (IRD, France); Institut national de la recherche agronomique (INRA, France); Universidade de São Paulo (Brazil).

Evidence of short-term belowground transfer of nitrogen from *Acacia mangium* to *Eucalyptus grandis* trees in a tropical planted forest. *Soil Biology and Biochemistry*, 91: 99-108. Doi: 10.1016/j.soilbio.2015.08.017



Marking a 26-month-old *Acacia mangium* by injection with 15N to study the rapid below-ground transfer of nitrogen to neighbouring eucalyptus trees: the bottom bottle contained 100 ml of distilled water before being connected to the top bottle, which contained 0.9 g of labelled nitrogen dissolved in 400 ml of distilled water, Itatinga, Brazil © R.R. Paula

ORGANIC WASTE RECYCLING

How to reduce the risks for market gardening systems in Dakar

Frédéric Feder, Dakar, Senegal, Recycling and Risk

In Africa, ever-increasing numbers of people live in cities, generating ever-greater amounts of organic waste. That waste, which results from urban, agricultural and agroindustrial activities, can be recycled to fertilize soils. However, it sometimes contains substances such as trace metals that can be toxic to crops and consumers. Researchers from CIRAD and their African partners recently tested the toxicity of two types of waste – sewage farm sludge and poultry manure – on

soils around Dakar, where market gardening is particularly widely practised. The study revealed that waste products increased trace metal availability in soils, and that availability was highly dependent on soil physicochemical properties, and also on the type of residual waste product and the dose applied. These results gave rise to recommendations as to the type of waste and doses to be used to minimize the risk of toxicity when using organic waste in the region.



PARTNERS. Université d'Abomey-Calavi (Benin); Institut Sénégalais de recherches agricoles (ISRA, Senegal); Institut de recherche pour le développement (IRD, France).

Caractérisation des risques de contamination des agrosystèmes périurbains de Dakar par les éléments traces métalliques. *Agronomie africaine*, 27: 69-82.

Lettuces fertilisées avec des boues de stationnement, dans la région périurbaine autour de Dakar
© F. Feder, CIRAD

GUADELOUPE

Eight new yam varieties tolerant of anthracnose

Denis Cornet, Petit-Bourg, Guadeloupe, Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (AGAP)

To help fight anthracnose, producers in the Caribbean now have access to eight new varieties tolerant of the fungus. They were developed through breeding and assessment operations by CIRAD and INRA, within the framework of the Agricultural Innovation and Transfer Network (RITA), in close partnership with producers. Anthracnose is a fungal disease that has affected yam crops in Guadeloupe since the 1970s. Affected yam plants produce tubers that weigh less than usual, resulting in substantial yield losses. The new tolerant varieties each have their own ID card to help producers choose varieties tailored to their requirements and constraints.



Symposium. «Multi-functional farming systems in a changing world». A large number of CIRAD researchers presented their approach to agro-ecology at Agro2015, the 5th International Symposium for Farming Systems Design (FSD), an international scientific network. The symposium, held in Montpellier from 7 to 10 September, was co-organized by the European Society of Agronomy (ESA) and Agropolis International, and attended by some 400 scientists from 40 countries.

<http://fsd5.european-agronomy.org/presentations.html>

MALI

Fertilizing cotton crops also benefits the soil and food crops

Aude Ripoche, Montpellier, France, Agro-ecology and Sustainable Intensification of Annual Crops (AIDA)

As fallow is abandoned, the cropping systems of West Africa are becoming increasingly fragile. Unless fertilizers are used, yields are likely to fall. In Mali, researchers from CIRAD and the IER have studied cropping systems in which cotton, sorghum and groundnut are grown in succession, to determine to what extent fertilizing cotton may impact on the productivity of other crops and soil fertility. The experiment, which lasted twenty-five years, highlighted the vital role played by cotton, but also raised questions as to the current potential of these types of cropping systems.

PARTNER. Institut d'économie rurale (IER, Mali).

Cotton as an entry point for soil fertility maintenance and food crop productivity in savannah agroecosystems: Evidence from a long-term experiment in southern Mali. *Field Crops Research*, 177: 37-48. Doi: 10.1016/j.fcr.2015.02.013



Cotton field in Mali © P. Duquê/CIRAD



The main objective of the RHIZOtest is to measure the amount of a given element transferred from soil to plant, with the advantage of enabling whole-plant measurements (both the aerial part and roots) © CIRAD

SOIL-PLANT TRANSFERS OF TRACE ELEMENTS

The RHIZOtest sets the standard

Matthieu Bravin, Saint-Denis, Réunion, Recycling and Risk

The RHIZOtest was granted a standard by the International Organization for Standardization (ISO) in 2015. This biotest, which is the joint property of CIRAD and INRA, measures trace element transfers from the soil to plants with a view to assessing the eco-toxicological risks. The standard validates both the tool and the methodology, and should pave the way for numerous applications. The RHIZOtest, which has been in development since 2009, is the first standardized biological method for measuring trace element transfers from the soil to plants. In the short term, the RHIZOtest is due to be adapted to measure other types of contaminants, such as nanoparticles and organic trace contaminants, for instance endocrine disruptors.

PARTNER. Institut national de la recherche agronomique (INRA, France).

ISO 16198:2015: soil quality - plant-based test to assess the environmental bioavailability of trace elements to plants.

CLIMATE

What sort of forecasts do farmers need?

Christian Leclerc, Montpellier, France, Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (AGAP)

What sort of climate information do farmers need? And how can we provide them with forecasts that will be truly useful? This is a complex question, involving a range of fields and requiring various types of data in order to make forecasts on the time and spatial scales on which farmers work and adjust them to the agricultural and technical contexts in which they are to be used. A comparative study conducted in Cameroon, Kenya and Argentina by scientists from an interdisciplinary research group, of which CIRAD is a member, recently showed that the climate data that are really useful to farmers vary substantially depending on the region and on farming practices. It is therefore not possible to provide every farmer with the same information, since each situation requires a forecast tailored to the farmer's specific requirements. Such adjustments can only be made by calling upon all the disciplines involved: climatology, agronomy, ethnology, economics, and geography.

PARTNERS. Centre de recherche de climatologie (CRC); Centre de recherches et d'enseignement en géosciences de l'environnement (CEREGE); Columbia University (USA); Institut de recherche pour le développement (IRD, France); Laboratoire d'océanographie et de climat (Locean); Sorbonne Universités (France); Universidad Nacional de San Martín (Argentina); Université d'Aix-Mar-



Sheltered vegetable growing in Kenya
T. Martin © CIRAD

seille (France); Université de Bourgogne (France); Université Paris-Diderot (France).

Ethnographic context and spatial coherence of climate indicators for farming communities: A multi-regional comparative assessment. *Climate Risk Management*, 8: 28-46. Doi: 10.1016/j.crm.2015.03.001

Cropping system dynamics, climate variability, and seed losses among East African smallholder farmers: A retrospective survey. *Weather, Climate and Society*, 6: 354-370. Doi: 10.1175/WCAS-D-13-00035.1

New project. System approach for the TRAnstition to bioDiversified agro-ecosystems - STRADIV. Fondation Agropolis, 2015-2018

STRADIV (French West Indies; central America: northern Nicaragua and Costa Rica; Burkina Faso; Brazil; Cameroon; Madagascar) intends to provide solutions to the main scientific obstacles preventing the successful ecological transition of agro-ecosystems.

BIOMASS AND NON-FOOD USES

Innovating to develop sustainable non-food uses for biomass

SENEGAL

Using traditional sweet sorghum varieties to create new multi-purpose varieties

Gilles Trouche, Montpellier, France, Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (AGAP)

Sweet sorghum has many advantages for farmers in the Sahel. It is well suited to the local climate and combines human food and animal feed production (grain and leaves) with energy production from the sugar in its stems. With a view to breeding the best varieties for these various uses, researchers from CERAAS and CIRAD studied traditional West African sorghum landraces, notably those from Senegal, which, in addition to grain production, also produce significant amounts of stem biomass with a high sugar content. The aim was to determine the traits and combinations of traits required to obtain an efficient multi-purpose sorghum variety, and also to identify potential parents for future breeding programmes. Research is continuing to account for the physiological processes at play.

PARTNERS. Centre d'études régional pour l'amélioration de l'adaptation à la sécheresse (CERAAS, Thiès, Senegal); Université Cheikh Anta Diop (Dakar, Senegal).

Assessment of the variability of Senegalese landraces for phenology and sugar yield components to broaden the genetic pool of multi-purpose sorghum. *Plant Genetic Resources*: 11 p. Doi: 10.1017/S1479262115000155

Diversity of head shapes and grain colours among the main sorghum races studied: Guinea, Caudatum, Durra © T. Tovignan/CERAAS



SUGARCANE

A crop that also produces energy

Jean-François Martiné, Montpellier, France, Agro-ecology and Sustainable Intensification for Annual Crops (AIDA)

With the growth in demand for biofuels, using sugarcane by-products such as bagasse and ethanol could become more cost-effective. However, it is necessary to determine the conditions in which production could be both optimum and compatible with high sugar yields. A team from CIRAD, working with the eRcane firm, embarked upon a complex, novel study of the entire production chain, from plot to mill, to determine the impact of production factors on biomass yield and quality, and on aerial biomass distribution between food and energy production. This novel study focused on an analysis of production of several end products, taking an overall, integrated approach. The approach proved appropriate for this complex situation with its many forms of antagonism when producing co-products. It served to play on environmental conditions, cropping practices, processing workshop operations, costs and prices, with a view to optimizing multi-purpose sugarcane production.

PARTNERS. South African Sugarcane Research Institute (SASRI, South Africa); eRcane (France); AgroParis-Tech (France).

Optimization of sugarcane farming as a multipurpose crop for energy and food production. *Global Change Biology: Bioenergy*, 7: 40-56. Doi: 10.1111/gcbb.12133



ALBICIDIN

An antibiotic of the future

Stéphane Cociancich, Montpellier, France, Biology and Genetics of Plant-Pathogen Interactions (BGPI)

A team from CIRAD, in collaboration with the Technical University of Berlin, recently characterized the structure of albicidin, an antibiotic produced by a bacterial pathogen of sugarcane, *Xanthomonas albilineans*. Albicidin is responsible for the appearance of the symptoms that characterize sugarcane leaf scald, but it is also a powerful antibiotic. Based on the structure of albicidin, the researchers developed a chemical synthesis protocol to produce it in large quantities. They were then able to prove that the synthetic molecule obtained had the same anti-bacterial effect as natural albicidin. The protocol, which has been patented, is a major step forward along the road towards using albicidin in pharmacopoeia.

PARTNER. Technische Universität Berlin (Germany).

The gyrase inhibitor albicidin consists of p-aminobenzoic acids and cyanoalanine. *Nature Chemical Biology*, 11: 195-197. Doi: 10.1038/nchembio.1734

Xanthomonas albilineans © CIRAD



Publication

A book, *Sustainability of bio-jetfuel in Malaysia*, J.-M. Roda et al. (CIRAD, 2015) sheds light on the issue of bio-jetfuel sustainability in the aviation sector, in which demand is growing rapidly in Asia. A centre of excellence to promote the development of bio-jetfuel for aviation has been set up in Malaysia, to study the biomass raw materials and processes required to satisfy demand.

SUSTAINABLE FOOD SYSTEMS

Ensuring food security in southern societies

ORGANIC OR CONVENTIONAL PRODUCTS

Discriminating by analysing their microbial ecology

Céline Bigot, Montpellier, France, Integrated Approach to Food Quality (QUALISUD)

The food crises of recent years have led European consumers to be more vigilant as regards the safety and origin of the products they consume. The popularity of organic agricultural products, amongst others, reflects the demand for healthy, natural and certified foods. But once they are on the market, how can we discriminate between a foodstuff produced by the organic sector and another produced by the conventional farming sector, using pesticides? This was the question posed in a study by CIRAD of the traceability of fruits, using an overall microbial molecular analysis method developed in its laboratories. The researchers based their work on the assumption that the chemical treatments used in conventional farming modify the microbial flora of products. They compared the diversity of the microbial flora of fruits farmed organically with that of fruits grown in the conventional sector, via an overall molecular analysis of the DNA of the microbial communities. Trials on nectarines, peaches, apples and bananas were highly conclusive. They showed that it was possible to distinguish fruits in terms of how they were produced, through statistical comparisons of their microbial profiles.

Discriminating organic and conventional foods by analysis of their microbial ecology: An application on fruits. *Food Control*, 48: 123-129. Doi: 10.1016/j.foodcont.2014. 03.035

Bunch of bananas from Guadeloupe
© C. Jenny/CIRAD



ENERGY, WATER, CARBON FOOTPRINT

Ways of improving cassava starch production

Thierry Tran, Bangkok, Thailand, Integrated Approach to Food Quality (QUALISUD)

The cassava starch industry is booming. However, most producing countries use inefficient techniques, which means excessive energy and water consumption and a significant environmental impact. To minimize that impact, researchers from CIRAD and their partners identified the operations that consumed the most energy and water and those that emitted the most greenhouse gas. This enabled them to come up with a set of technical solutions to improve the performance of cassava starch extraction: producing biogas from effluent, to reduce and even replace fossil fuel use, and improving the energy efficiency of drying, which consumes the most heat energy, and of grating, which consumes the most electricity. These improvements should also cut greenhouse gas emissions, which are primarily the result of non-renewable energy use and effluent fermentation. This research should enable technology transfers, subject to certain adaptations, between countries in the South.

PARTNERS. Universidad del Valle (Univalle, Colombia); Centro Internacional de Agricultura Tropical (CIAT, Colombia); Deriyuca LTDA (Colombia); Kasetsart University (Thailand); Hanoi University of Science and Technology (HUST, Vietnam); Université Paris-Est Créteil (France).

This research benefited from financial support from and the activities of the CGIAR (www.rtb.cgiar.org) Roots, Tubers and Bananas Programme (CRP-RTB), in which CIRAD is a partner, particularly as regards postharvest techniques.



A large-scale flash dryer for cassava starch, Thailand
© T. Tran/CIRAD

A comparison of energy use, water use and carbon footprint of cassava starch production in Thailand, Vietnam and Colombia. *Resources, Conservation and Recycling*, 100: 31-40. Doi: 10.1016/j.resconrec.2015. 04.007

Biogas reduces the carbon footprint of cassava starch: a comparative assessment with fuel oil. *Journal of Cleaner Production*, 1-8. Doi: 10.1016/j.jclepro.2015. 06.138



An *Antestiopsis orbitalis* bug larva on a coffee bean © R. Babin/CIRAD

COFFEE

The bacterium behind “potato taste” has been identified

Christian Cilas, Montpellier, France, Pests and Diseases: Risk Analysis and Control [Bioagresseurs]

The “potato taste” of some coffees reduces their quality and value. It is caused by a molecule produced following the introduction of a bacterium into the beans. A team from CIRAD, working with the Institut Pasteur, recently identified the bacterium. It is a new species, christened *Pantoea coffeiphila*. Based on this work, selective detection kits for the bacterium should enable further research to provide a better understanding of the ecology of the bacterium in the coffee growing zones of the Great Lakes region.

PARTNER. Institut Pasteur (France).

Pantoea coffeiphila sp. nov., cause of the ‘potato taste’ of Arabica coffee from the African Great Lakes region. *International Journal of Systematic and Evolutionary Microbiology*, 65: 23–29. Doi: 10.1099/ij.s.0.063545-0

DAIRY BASIN DYNAMICS

Between globalization and territorialization

Christian Corniaux, Dakar, Senegal, Mediterranean and Tropical Livestock Systems [SELMET]

Agricultural operations and territories, which are subject to the forces of globalization and territorialization, are evolving. This book analyses the reconfigurations under way in seven dairy basins worldwide, in France, Brazil, Uruguay, Senegal and Vietnam. The authors shed light on the development pathways taken by these basins by looking at the joint changes in livestock production systems, territories and the supply chains on which they depend. They demonstrate the diversity of their histories, which are the result of exclusions and also of complementarities within a given territory between more local and more global types of development. The book fits in with the very current debate on how to support changes within territories, and takes account of local/global interactions with a view to sustainability.

Voies lactées: dynamique des bassins laitiers entre globalisation et territorialisation. Cardère, 320 p.

Dairy cows in the mountains, on rich pasture © Sophie Madelrieux



Meetings

dP Malica (Markets and Agriculture Linkages for Cities in Asia), one of CIRAD’s platforms in partnership for research and training, helped organize two seminars:

> On rice branding strategy in Vietnam, in Hanoi on 22 September, with the Vietnamese Ministry of Agriculture and National Office of Intellectual Property, NOIP.

> On food consumption, urbanization and rural change, in Hanoi on 1 and 2 October, with the Institut international pour l’environnement et le développement (IIED) and the Vietnam Academy of Agricultural Sciences (VAAS), with the support of the International Fund for Agricultural Development (IFAD). The seminar brought together representatives of the political authorities, producers and civil society.

A study has shown how small-scale artificial drying of cassava starch and flour can cut energy costs. It was conducted by CIRAD, CIAT, the IITA, Kasetsart University, the NSTDA-BIOTEC and the Vietnam Academy of Agricultural Sciences (VAAS) on the industrial dryers used in various African, Asian and Latin American countries in 2013–2015, and presented to industrialists at a workshop in Bangkok, Thailand, from 2 to 4 December.

ANIMAL AND PLANT HEALTH

Understanding, anticipating and managing the risks linked to animal and plant pests and diseases

WEST INDIES

Using service plants to control bacterial wilt of tomato

Péninna Deberdt, Le Lamentin, Martinique, Agro-ecological Functioning and Performances of Horticultural Systems (HortSys)

Service plants can considerably reduce the incidence of tomato bacterial wilt in Martinique. Two in particular – *Crotalaria spectabilis* and *Raphanus sativus* cv. Melody – have proved effective as previous crops, resulting in a 60 to 80% reduction in the disease. The way in which these two plants act has yet to be pinpointed. As it is not based on a reduction in *R. solanacearum* densities in the soil, it is likely that other soil microbe populations are involved. These results bear witness to the complexity of the relations between plants and microorganisms. In practice, however, we can already recommend these two short-cycle plants well suited to tropical environments, as part of an agro-ecological strategy for controlling tomato bacterial wilt in Martinique.

PARTNER. Institut national de la recherche agronomique (INRA, France).



Experiment in a climate chamber showing *Crotalaria juncea* on the left and right and *C. spectabilis* in the centre © P. Deberdt/CIRAD

Crotalaria spectabilis and *Raphanus sativus* as previous crops show promise for the control of bacterial wilt of tomato without reducing bacterial populations. *Journal of Phytopathology*, 163: 377–385. Doi: 10.1111/jph.12333

AGRO-ECOLOGICAL PROTECTION OF MARKET GARDEN CROPS IN BENIN

Are insect nets cost effective?

Laurent Parrot, Montpellier, France, Agro-ecological Functioning and Performances of Horticultural Systems (HortSys)

In Benin, some market gardeners cover their crops with nets to protect them against insects while reducing synthetic insecticide use. To assess the merits of this innovation, CIRAD researchers conducted a cost:benefit analysis among cabbage growers. The results were unequivocal: the

cost:benefit ratio was almost twice as high and nett margins were three times higher for farmers using nets, and above all, yields and incomes were much more stable and better managed. This also demonstrated the merits of this type of analysis when designing and disseminating innovations.

PARTNERS. Centre régional pour la promotion agricole Atlantique-Littoral (CeRPA, Benin); Institut national des recherches agricoles (INRAB, Benin); International Center of Insect Physiology and Ecology (ICIPE, Kenya); Michigan State University (USA); Université d'Abomey Calavi (Benin).

Cost:Benefit analysis of insect net use in cabbage in real farming conditions among smallholder farmers in Benin. *Crop Protection*, 78: 164–171. Doi: 10.1016/j.cropro.2015.09.003



Cabbage crops protected with nets, in Benin © L. Parrot/CIRAD

INSECT CONTROL

When do desert locusts become gregarious?

Cyril Piou, Agadir, Morocco, Centre for Biology and Management of Populations (CBGP)

Desert locusts, which are usually solitary and inoffensive, can very rapidly become gregarious and form gigantic swarms that devastate vegetation. What are the mechanisms behind this and what factors trigger it? Along with the FAO Commission for Controlling the Desert Locust in the Western Region and several other organizations in North and West Africa, CIRAD has undertaken research to pinpoint the environmental conditions and insect densities that lead desert locusts to become gregarious. The study, conducted in Mauritania, showed that gregarization of adults was easier in sparse vegetation, but that hopper gregarization was not significantly influenced by vegetation. This research raises new questions about behavioural transformation processes, which are key to our understanding of the gregarization phenomenon.

PARTNERS. Commission de lutte contre le criquet pèlerin en région occidentale (CLCPRO); Centre national de lutte antiacridienne (CNLA, Mauritania); Centre national de lutte anti-acridienne (CNLAA, Morocco); Institut agronomique et vétérinaire Hassan II (IAV, Morocco); Centre national de lutte contre le criquet pèlerin (CNLCP, Mali).

Estimation of density threshold of gregarization of desert locust hoppers from field sampling in Mauritania. *Entomologia Experimentalis et Applicata*, 156: 136–148. Doi: 10.1111/eea.12323

Characterizing phase-related differences in behaviour of *Schistocerca gregaria* with spatial distribution analysis. *Entomologia Experimentalis et Applicata*, 156: 128–135. Doi: 10.1111/eea.12318

Concentration of desert locust hoppers on tufts of vegetation, Mauritania © S. Cissé/CIRAD–CLCPRO



CIRAD is at the cutting edge of avian influenza epidemiology in Africa

By 2005-2006, at the height of the H5N1 virus epizootic, the dynamics of how avian influenza spreads had only been studied in boreal and temperate regions. Since the H5N1 virus was also a threat to the livelihoods of many farmers in southern countries, CIRAD and its partners decided to tackle the issue. Its ground-breaking work in tropical zones has served to decipher the ways in which the virus circulates and persists in wild and domestic birds in Africa. It resulted in five publications in 2015.

Interview with Nicolas Gaidet, ecologist at CIRAD

You were the first people to work on the ecological dynamics of avian influenza transmission in Africa, and your work has really set the cat amongst the pigeons...

Nicolas Gaidet: Our results, obtained in collaboration with numerous partners, have cast doubt on some of the major paradigms regarding influenza ecology in wild birds. For instance, at one time, avian influenza was not thought to be maintained in tropical zones, due to unfavourable climate conditions (high temperatures, aridity). We showed that on the contrary, viruses can persist all year round in wild bird communities in Africa.

What else did you find out about how these viruses circulate in Afro-tropical ecosystems?

N.G.: A wide range of wild species are involved in transmitting virus strains. However, there are differences between temperate and tropical regions in terms of host ecological dynamics. For instance, in northern countries, birds all

reproduce in the spring and early summer. There is a seasonal infection peak in the late summer, associated with the simultaneous, mass arrival of young, non-immunized birds. In tropical zones, reproduction is spread throughout the year, so there is no epidemic peak, but rather low-level, continuous circulation. To give another example, birds in Africa congregate at the end of the dry season at permanent wetlands, where proximity favours virus transmission. In temperate regions, birds gather just before migrating. Epidemiology is therefore closely linked to host ecology.

You are using the One Health multi-disciplinary approach in your work. What exactly is it?

N.G.: The One Health concept considers that animal, human and ecosystem health are inter-linked. In our teams, we have veterinary surgeons, ecologists, epidemiologists, and so on. This multi-disciplinary approach has allowed us to put the avian influenza issue into context within the different socio-ecosystems concerned.

How can these diseases be controlled?

N.G.: There is a risk of virus transmission between wild and domestic birds. We have identified hitherto overlooked "bridge species" that are capable of forging an epidemiological link between the main wild hosts, such as wild ducks, and the target hosts, domestic poultry species. This discovery paves the way for a new disease control method: limiting contact between domestic birds and bridge species. We also think it is necessary to take a fresh look at production methods. Intensive farms are comprised of genetically very closely related birds at very high densities (up to 22 chickens/m²). These intensive farms favour the selection and emergence of highly pathogenic virus strains; they are ideal breeding grounds for the virus!

Knob-billed duck
(*Sarkidiornis melanotos*) caught
in the inner Niger delta (Mali)
© N. Gaidet



What is the current avian influenza situation worldwide?

N.G.: Even though there is much less media coverage than in 2005-2006, highly pathogenic virus epizootics have taken off again since late 2014. In 2015, the number of cases of infection by the H5N1 virus in humans (143 people infected, of whom 43 died) was the highest since 2003. The virus has also reappeared in poultry and wild birds in West Africa, the Middle East and Eastern Europe. Three highly pathogenic virus strains related to Asian H5N1, have been seen for the first time in North America. And in late 2015, France saw a flare-up of cases in farms in the Southwest. We must remember that the steps taken to prevent the disease spreading have significant economic consequences. For farmers and other stakeholders in the sector, this virus is a major curse.

Nicolas Gaidet, Montpellier, France,
Animal and Integrated Risk Management (AGIRs)

Field mission to the Banc d'Arguin National Park,
Mauritania © CIRAD





Intercropping tomato plants and geraniums
© T. Martin/CIRAD

AGRO-ECOLOGICAL CROP PROTECTION A world of smells to explore

Thibaud Martin, Emilie Delétré, Nairobi, Kenya,
Agro-ecological Functioning and Performances
of Horticultural Systems (HortSys)

Lemongrass, citronella, cinnamon, thyme, and so on... could these plants whose smell repels insects be used to protect horticultural crops? This is the question some researchers from CIRAD asked when looking into the repellent compounds in the extracts and essential oils of several such plants. The team first of all sought and characterized insect-repellent compounds in the extracts or essential oils of plants reputed for their repellent properties, then identified the active molecules and determined their efficacy. These substances could eventually be added to the arsenal of agro-ecological crop protection weapons and help replace chemical pesticides. They could be used in diffusers, placed within or around crops so as to repel pests or mask any attractive smell given off by the crop.

PARTNERS. European Biological Control Laboratory (USDA-ARS-EBCL, France); Faculté de pharmacie de Montpellier (France); Institut de recherche pour le développement (IRD, France); International Center of Insect Physiology and Ecology (ICIPE, Kenya)

Naturally occurring bioactive compounds from four repellent essential oils against *Bemisia tabaci* white flies. *Pest Management Science*, 11 p. Doi: 10.1002/ps.3987

Electrophysiological and behavioral characterization of bioactive compounds of the *Thymus vulgaris*, *Cymbopogon winterianus*, *Cuminum cyminum* and *Cinnamomum zeylanicum* essential oils against *Anopheles gambiae* and prospects for their use as bednet treatments. *Parasites and Vectors*, 8: 316. Doi: 10.1186/s13071-015-0934-y

Behavioral response of *Bemisia tabaci* (Hemiptera: Aleyrodidae) to 20 plant extracts. *Journal of Economic Entomology*, 108: 1890-1901. Doi: 10.1093/jee/tov 118

BOLLWORM RESISTANCE TO Bt COTTON

Seed mixtures are less effective than external refuges

Thierry Brévault, France, Agro-ecology and Sustainable Intensification for Annual Crops (AIDA)

Growing cotton that has been genetically modified to produce insecticidal toxins inevitably leads to the development of resistance in the target insects. To slow down the phenomenon, seed firms can now supply farmers with ready-to-use mixtures of modified and non-modified seeds, which are intended to serve as refuges. However, are these refuges, inside crop plots, as effective as the external refuges recommended to date? Researchers from CIRAD and the University of Arizona recently demonstrated that these mixtures carry risks, since they increase the dominance of insect resistance. They observed that with a mixture of Bt and non-Bt plants, the dominance of insect resistance to the Bt plants was greater than in a crop of exclusively Bt cotton. In particular, this was because "heterozygous" insects, ie those that carry a single resistance allele, were capable of surviving by moving to non-Bt plants.

PARTNER. University of Arizona (USA).

A seed mixture increases dominance of resistance to Bt cotton in *Helicoverpa zea*. *Scientific Reports*, 5: 9807. Doi: 10.1038/srep09807

Experiments in greenhouses serve to compare the survival of bollworms on Bt cotton plants with ready-to-use mixtures of modified and non-modified seeds, and with external refuges

© T. Brévault/CIRAD ➤



COCOA AGROFORESTS

Redistributing vegetation serves to regulate pest and disease attacks

Christian Cilas, Montpellier, France, Pests and Diseases: Risk Analysis and Control (Bioagresseurs)

Cocoa agroforests are complex agrosystems similar to natural ecosystems. That complexity is an asset in terms of managing cocoa pests and diseases. But how does it serve to regulate their presence and minimize the intensity of their attacks? Based on studies in Cameroon and Costa Rica, researchers from CIRAD and their partners recently demonstrated the predominant role of the spatial structure of such agroforests in terms of regulation. In Costa Rica, frosty pod intensity increased the more the forest trees were clustered. In Cameroon, black pod incidence increased with the density of the understorey in the plot, and mirid attacks were less frequent the more regularly the shade trees were distributed. This study provided an accurate description of the structure of complex tropical agro-ecosystems and of the relations between the structures observed and pest and disease regulation. As part of an agro-ecological crop management approach, it was an initial step towards identifying and understanding the ecological mechanisms involved in natural cocoa pest and disease regulation on a plot scale.

PARTNERS. African Insect Science for Food and Health (ICIPE, Kenya); Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Costa Rica); Institut de recherche agricole pour le développement (IRAD, Cameroon); Instituto Interamericano de Cooperación para la Agricultura (IICA, Costa Rica); Montpellier Supagro (France).

Tree spatial structure, host composition and resource availability influence mirid density or black pod prevalence in cacao agroforests in Cameroon. *PLoS One*, 9: e109405. Doi: 10.1371/journal.pone.0109405

Shade tree spatial structure and pod production explain frosty pod rot intensity in cacao agroforests, Costa Rica. *Phytopathology*, 104: 275-281. Doi: 10.1094/PHYTO-07-13-0216-R

A cocoa agroforestry plot in Cameroon
© P. Jagoret/CIRAD



A word from one of our partners

Health risks: from a regional research platform to an international Masters programme



How can emerging health risks in Southeast Asia be managed? The GREASE platform in partnership is looking for answers, notably through the One Health approach. The platform's latest activities include the launch of a new double Masters degree programme between France and Thailand: InterRisk.

Tanu Pinyopummintr, Vice Dean for International Affairs at the Faculty of Veterinary Medicine (Kasetsart University) and member of the GREASE Steering Committee, talks about the launch of this innovative programme.

"The idea of a new training programme has often been broached during the close collaboration between the Kasetsart Faculty of Veterinary Medicine and CIRAD. It was while building the ComAcross project [Companion Approach for Cross-sectoral collaboration in health risks management in South-East Asia] that the decision was finally made to turn talk into action. The ComAcross programme aims to build capacity, particularly in the most vulnerable countries in Southeast Asia, to respond to and prepare for the risks linked to emerging infectious diseases at the animal-human-environment interface. The project is founded on the development of inter-sectorial and multi-stakeholder collaborations aimed at implementing the One Health approach. The InterRisk Masters is a major component in the ComAcross project.

It is coordinated by three members of the GREASE platform: Kasetsart University (KU, Thailand), the École nationale vétérinaire de Toulouse (INP-ENVT,

France) and CIRAD (France). It offers students the opportunity of obtaining two diplomas (KU and Toulouse University). This international Masters offers a comprehensive academic course in the assessment and management of health risks, in line with the One Health approach.

The two-year course uses many tools relating to veterinary public health, epidemiology, statistics, socioeconomics and environmental science, which form the heart of the One Health approach. Theoretical teaching is combined with interactive methods such as problem-solving based on true-life cases, field trips, laboratory techniques, use of innovative IT tools, etc. The InterRisk Masters provides students with real practical experience and enables them to join an interdisciplinary network of professionals already involved in the One Health sector."

Buffalo, Phu Tho province, North Vietnam
V. Porphyre © CIRAD



dP GREASE: Emerging risks in Southeast Asia

How can the health risks that emerge at the animal-human-environment interface be managed? The risks are particularly significant in Southeast Asia, which combines numerous factors: climate change, deforestation, urban growth, changing production conditions and commercial circuits, etc. The GREASE platform in partnership has opted for the One Health approach, which takes account of the interdependence between epidemiological and social dynamics, between biodiversity and health, and between animal and human health, in order to prevent and combat emerging diseases.

Partners: National Veterinary Research Institute (NAVRI, Cambodia); National Institute of Veterinary Research (NIVR, Vietnam); Central Mindanao University (CMU, College of Veterinary Medicine, Philippines); Kasetsart University (KU, Faculty of Veterinary Medicine, Thailand); National University of Laos (NUoL, Faculty of Agriculture); Universitas Gadjah Mada, Yogyakarta (UGM, Indonesia); CIRAD (UPR AGIRs, UMR InterTryp, UMR MOISA, UPR GREEN, UMR QUALISUD).

Chickens' eggs stored in egg trays, in Cambodia
V. Porphyre © CIRAD



The many advantages of working within GREASE

"The GREASE structure is particularly suitable for implementing the One Health approach, which calls for inter-disciplinary and inter-institutional collaboration on a local, national and regional level.

Conferences, training courses, meetings, workshops, visits, and so on and so on. The platform offers its members many opportunities to interact and collaborate with experts and students from all over the world. For instance, the third International Congress on Pathogens at the Human-Animal Interface (ICOPHAI 2015) was held in Thailand in 2015. This collaborative operation has naturally paved the way for novel topics such as participatory epidemiology, companion modelling, geographic information systems, etc. GREASE is helping build capacity amongst its members, who in turn pass on the knowledge acquired through training programmes, hence fulfilling the objective of "training teaching staff" for the region."

CONTAGIOUS BOVINE
PLEUROPNEUMONIA
IN AFRICAA disease in search of
epidemiological
data

François Roger, Montpellier, France & Bangkok, Thailand, Animal and Integrated Risk Management (AGIRs),

François Thiaucourt, Montpellier, France, Emerging and Exotic Animal Disease Control (CMAEE)

Contagious bovine pleuropneumonia is endemic in sub-Saharan Africa where, despite its significant socioeconomic impact, it has nevertheless been largely overlooked to date. There is a lack of reliable data in terms of epidemiology in particular. A survey conducted with the support of CIRAD filled in the gaps for Mali and demonstrated that thorough field studies in all the countries affected by the disease would be of significant interest. Those studies could serve as the basis for effective disease management, to ensure better control and eventually its eradication in Africa. The researchers analysed more than 8000 blood samples from 200 cattle herds throughout the country. Their results confirmed that the disease was endemic in Mali: 86% of herds and 18% of animals showed positive, with variations between regions, age groups and sex of cattle. The survey was a vital first step on the road to drafting disease control strategies for Mali.



Cattle herders at milking time, Sémébougou, Mali
© C. Corniaux/CIRAD

PARTNERS. Laboratoire central vétérinaire, Bamako (Mali); Ecole nationale vétérinaire de Toulouse (INP-ENVT, France).

Seroprevalence of contagious bovine pleuropneumonia (CBPP) in Mali. *Tropical Animal Health and Production*, 47: 395-402. Doi: 10.1007/s11250-014-0738-7

Support for the prevention of health risks. In: *Family farming and the worlds to come*. Springer Netherlands, p. 267-283.

<http://www.springer.com/us/book/9789401793575>

VECTOR CONTROL IN SENEGAL

New prospects
for Bluetongue and
African horse sickness

Geoffrey Gimonneau, Bobo-Dioulasso, Burkina Faso, Host-Vector-Parasite-Environment Interactions in Neglected Tropical Diseases due to Trypanosomatids (InterTryp)

In Senegal, midges of the genus *Culicoides* transmit bluetongue and African horse sickness (AHS), two very serious viral diseases. However, little is known about these insects and their behaviour, despite the fact that such information is vital in controlling vectors and preventing disease transmission. A team from CIRAD and ISRA have conducted a series of taxonomic and bio-ecological studies with a view to identifying the species involved in AHS transmission, their habitats and their activities. The researchers were able to update the list of *Culicoides* species found in Senegal, and compare the trophic preferences, in other words the choice of hosts, and circadian rhythms of the main local species. During their studies, a dozen or so species were captured regularly, the most common of which were *Culicoides oxystoma* and *C. imicola*. Although neither species has yet been formally identified as a vector of AHS in Senegal, the former has been found to carry bluetongue in the field in India, while the latter is a known vector of both African horse sickness and bluetongue in South Africa. These results will serve to develop prevention and vector control methods suitable for local *Culicoides* populations.

PARTNERS. Institut sénégalais de recherches agricoles (ISRA, Senegal); Université Cheikh Anta Diop (Senegal); Institut national de la recherche agronomique (INRA, France).

Circadian activity of *Culicoides oxystoma* (Diptera: Ceratopogonidae), potential vector of bluetongue and African horse sickness viruses in the Niayes area, Senegal. *Parasitology Research*, 114: 3151-3158. Doi: 10.1007/s00436-015-4534-8

Host preferences and circadian rhythm of *Culicoides* (Diptera: Ceratopogonidae), vectors of African horse sickness and bluetongue viruses in Senegal. *Acta Tropica*, 149: 239-245. Doi: 10.1016/j.actatropica.2015.06.012

Culicoides (Diptera: Ceratopogonidae) midges, the vectors of African horse sickness virus: a host/vector contact study in the Niayes area of Senegal. *Parasites and Vectors*, 8: 39. Doi: 10.1186/s13071-014-0624-1

A Palearctic midge species, *Culicoides nubeculosus*

© J.B. Ferré/EID-Med



Fulani zebu, Burkina Faso © S. Thévenon/CIRAD

AFRICAN ANIMAL TRYPANOSOMOSIS

Shorthorn taurine breeds are
extremely tolerant

Sophie Thévenon, David Berthier, Montpellier, France, Host-Vector-Parasite-Environment Interactions in Neglected Tropical Diseases due to Trypanosomatids (InterTryp)

African animal trypanosomosis is an obstacle to the development of cattle rearing in tsetse fly-infested zones. However, not all cattle breeds have the same degree of susceptibility to the disease. Some West African breeds are even tolerant. Little use has yet been made of this diversity in breeding programmes, for want of data on its molecular and evolutionary origin. CIRAD, working with CIRDES, launched a wide-ranging study to analyse the response to infection of five West African breeds. Its conclusions have shown that shorthorn taurine breeds are remarkably tolerant of trypanosomosis. This is the case, for instance, for the Lagunaire and Baoulé breeds, which are as tolerant of the disease as the reference breed, N'Dama, and remarkably well suited to harsh environments. Making use of the genetic diversity of cattle breeds by combining trypanosomosis tolerance with better productivity can serve to control the disease more effectively and reduce the cost of control and its adverse effects on the environment, while limiting pathogen circulation.

PARTNERS. Centre international de recherche-développement sur l'élevage en zone subhumide (CIRDES, Burkina Faso); Institut national de la recherche agronomique (INRA, France).

The AATTOL (African Animal Trypanosomosis Tolerance) project is funded by the Agence nationale de la recherche (ANR).

A comparison of phenotypic traits related to trypanotolerance in five West African cattle breeds highlights the value of shorthorn taurine breeds. *PLoS One*, 10: e0126498 [21 p.]. Doi: 10.1371/journal.pone.0126498

TSETSE FLIES

Optimizing eradication using satellite imagery and genetics

Jeremy Bouyer, Addis-Abeba, Ethiopia, Emerging and Exotic Animal Disease Control (CMAEE) and Host-Vector-Parasite-Environment Interactions in Neglected Tropical Diseases due to Trypanosomatids (InterTryp)

Isolated populations of tsetse flies constitute the best targets for eradication campaigns, but they are difficult to detect. By combining analysis of satellite images and genetics, researchers at CIRAD and their partners have developed a methodology for identifying these populations on a continental level in Africa. This original methodology could not have been developed without close cooperation between ecologists, geographers, population geneticists and modellers. In particular, it has the advantage of moving away from expert opinions, which are subjective and may in some cases be a source of error. This approach, which is the fruit of eight years' work, is currently being transferred to other vectors, such as the midge *Culicoides imicola*, in the Mediterranean basin. It can also be used to study the genetic structure of virus populations on the scale of a whole continent in order to develop the most appropriate vaccination strategies based on this. Finally, it will facilitate the work of conservation biologists, for example by helping them to identify exchange corridors between certain endangered animal populations living in increasingly fragmented ecosystems.

PARTNERS. Centre international de recherche-développement sur l'élevage en zone subhumide (CIRDES, Burkina Faso); Food and Agriculture Organization of the United Nations (FAO, Ethiopia); Insect Pest Control Laboratory (IPCL, Austria); Institut de recherche pour le développement (IRD, France); Institut national de la recherche agronomique (INRA, France); Institut sénégalais de recherches agricoles (ISRA, Senegal); University of Zimbabwe; West African Science Service in Climate Change and Adapted Land Use (WASCAL, Senegal).

Mapping landscape friction to locate isolated tsetse populations candidate for elimination. *Proceedings of the National Academy of Sciences of the United States of America*, 112: 14575-14580. Doi: 10.1073/pnas.1516778112



Tsetse fly in its natural environment
© O. Esnault/CIRAD

PUBLIC ACTION FOR DEVELOPMENT

Supporting public action to reduce structural inequality and poverty

MEXICO

Are payments for conserving biodiversity effective?

Driss Ezziine de Blas, Mexico City, Mexico, Forests and Societies (F&S)

In Mexico, a programme of payments for environmental services (PES) invites forest communities to commit to protecting a wooded area rich in biodiversity in exchange for an annual payment. But how can the efficacy of the programme be measured without determining the area of forest that would have been lost without it? Researchers from CIRAD and their partners recently developed a method for measuring that area. It is a spatial method consisting in drawing a grid of "usage units", each of which has different attributes from a socioeconomic point of view, and also different spatial attributes linked to its proximity to units that had been either totally or partly cleared. The aim was to compare the change in units included in the programme with that of the most similar units in terms of socioeconomic, ecological and spatial attributes, but not included in the programme. The method served to quantify the impact of the programme: 10 to 15% of wooded areas have been preserved thanks to the payments.

PARTNERS. Universitat Autònoma de Barcelona (Spain); University of British Columbia (Canada); University of Illinois (USA); Colegio de la Frontera Sur (Mexico).

How effective are biodiversity conservation payments in Mexico? *PLoS One*, 10: e0119881 [20 p.]. Doi: 10.1371/journal.pone.0119881

Invaluable project: www.invaluable.fr

PES can target a wide range of ecosystem services, such as hydrological regulation



© S. Costedoat/Universitat Autònoma de Barcelona

A platform to promote and support local smallholder innovations

Michel Dulcire, Montpellier, France, Innovation and Development in Agriculture and the Food Sector (Innovation)

A new collaborative platform has been launched by CIRAD, the Fondation de France, the Comité français pour la solidarité internationale, Groupe Initiative and the Inter-réseaux association, to promote smallholder and local innovations in southern countries. Its aim is to identify, study and promote local innovations in favour of family farming in the South. Local agricultural innovation is a key factor for adapting and developing agriculture in the constrictive context of southern countries. However, knowledge of these innovations, their promotion, and above all their dissemination, is too often lacking. The study of these innovations, through the platform, should help design new agricultural knowledge and innovation systems. This study should identify the factors for success and the long-term impact of these innovations and serve to define the preconditions for a change of scale platform. Over and above the study, the platform aims to ensure the effective dissemination and promotion of the experience and knowledge generated to development players and decision-makers.

A young farmer passing on her knowledge and practices to other farmers, Venezuela © CIRAD



Health security

Using participatory modelling to promote collective action

Aurélien Binot, Bangkok, Thailand, Animal and Integrated Risk Management (AGIRs)

Stakeholder capacity building, global thinking, collaboration and dialogue: in the field of public health, CIRAD's teams have opted for interdisciplinary, participatory and collaborative approach. To do so, they have developed a methodological framework based on participatory modelling, which should enable the different stakeholders to share the same view of problems and take on board the One Health approach, in which human, animal and environmental health are interlinked. This participatory modelling approach sets out to view public health, both human and veterinary, as a "common", to the same extent as biodiversity, whose governance is built on various levels. It serves to reveal the ways in which players can take collective action, stimulates development of such action, and looks at the ways in which these collective management instruments can be coordinated with public policies, depending on the social, political, cultural and economic issues. The aim is to build new multi-stakeholder health risk management strategies.

PARTNERS. Kasetsart University (Thailand); Institut Pasteur du Cambodge (Cambodia); University of Oxford (UK); National University of Laos.

A framework to promote collective action within the One Health community of practice: Using participatory modelling to enable interdisciplinary, cross-sectoral and multi-level integration. *One Health*, 1: 44-48. Doi: 10.1016/j.onehlt.2015.09.001



Survey of fishmongers in Khon Kaen, Thailand
© CIRAD

SOCIETIES, NATURE AND TERRITORIES

Helping societies manage territories sustainably

FORESTS OF THE CONGO BASIN Multiple-use management

Guillaume Lescuyer, Bogor, Indonesia,
Forests and Societies (F&S)

The forests of the Congo Basin cover 200 million hectares and feed 60 million people. This vast region, with its wealth of resources, has often fallen prey to conflicts of use between the logging industry and the local communities that make a living from agriculture, hunting and small-scale logging. Based on an analysis of those conflicts, a team from CIRAD came up with ways of introducing multiple-use management of these forests, which would be both fair and sustainable. The aim was to sideline matters relating to international commons, such as biodiversity protection or carbon sequestration, and highlight the concrete benefits such management methods can have for forest users. According to the authors, this is the key to successful multiple-use forest management: if stakeholders are to change their behaviour, they have to have a clear idea of the costs and benefits associated with implementing such methods, and persuasive financial incentives have to be established, taking those costs and benefits into account.

PARTNERS. Center for International Forestry Research (CIFOR, Cameroon); Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, Cameroon); Université de Clermont I (France); Université de Dschang (Cameroon); Université de Kisangani (DR Congo); Institut de recherche en écologie tropicale (IRET, Gabon); Institut de recherche agricole pour le développement (IRAD, Cameroon); Bioversity International (Italy).

Promoting multiple-use forest management: which trade-offs in the timber concessions of Central Africa? *Forest Ecology and Management*, 349: 20-28. Doi: 10.1016/j.foreco.2015.04.013



Area cleared by slash-and-burn within a concession © G. Lescuyer/CIRAD

FORESTS WORLDWIDE Tree functional traits have consistent effects on competition

Sylvie Gourlet-Fleury, Montpellier, France, Forests and Societies (F&S)

An unprecedented study involving researchers from CIRAD recently demonstrated that wood density, specific leaf area and the maximum height of the trees that make up a forest could be used to predict the intensity of competition between species. This work helps explain the dynamics at play in forests the world over. It showed that the fact that two species have very different functional traits does not necessarily mean that there will be less competition between them, contrary to the conventional hypothesis that the more the functional traits of two species differ, the less likely they are to compete with each other, since they are assumed to occupy distinct ecological niches. In reality, functional traits are responsible for compromises in terms of growth that influence the degree of competition in complex ways and, when regenerating forest landscapes, it is therefore possible to make use of very different species.



Transition between two forest communities: temperate forest with *Nothofagus* (left) and sub-tropical rainforest (right), on the border between Queensland and New South Wales, Australia. Within these communities, tree density is high. The trees, which belong to various species with different traits, compete strongly for resources © Robert Kooyman

Plant functional traits have globally consistent effects on competition. *Nature*, 529: 204-207. Doi: 10.1038/nature16476

TERRITORIAL ECOLOGY A promising research framework

Tom Wassenaar, Montpellier, France, Recycling and Risk

In a context in which farming and agrifood systems are the object of new expectations and standards, agricultural research needs to ask itself about the subjects and scales on which it works and its approaches. Depending on the topic concerned, renewing the objects of agricultural research may mean defining the boundaries of systems well beyond those of agriculture and agrifoods, and the preservation and overall efficiency of resource use within such complex activity systems can serve as key indicators of their performance. This is the conclusion reached by a researcher from CIRAD who was studying waste recycling, and whose work led him to identify industrial ecology, more commonly referred to in French as territorial ecology, as an appropriate research framework. That framework should ensure that agricultural research is recognized as an essential, legitimate player in industrial symbiosis. This offers good prospects for promoting the aims of sustainable development within the overall changes under way in these complex systems.

Reconsidering industrial metabolism: from analogy to denoting actuality. *Journal of Industrial Ecology*, 19: 715-727. Doi: 10.1111/jiec.12349

Village and agricultural terroir on the slopes of a volcano in Bali, Indonesia
© G. Trébui/CIRAD



WASTE RECYCLING IN SUB-SAHARAN AFRICA

How to change competition into synergy

Nadine Andrieu, Cali, Colombia, Innovation and Development in Agriculture and the Food Sector (Innovation)



Direct sowing on a crop mulch in Koumbia, Burkina Faso

for each of those scales, crop residue collection thresholds capable of limiting the competition between ensuring soil cover and feeding livestock. Simple simulation tools that take account of the synergies and tensions between types of use, such as those used for these studies, can fuel this dialogue between stakeholders.

PARTNERS. African Conservation Tillage Network (Burkina Faso); Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT, Ethiopia); Centre international de recherche-développement sur l'élevage en zone subhumide (CIRDES, Burkina Faso); Institut national de la recherche agronomique (INRA, France); Wageningen University (Netherlands).

Biomass transfers and nutrient budgets of the agro-pastoral systems in a village territory in south-western Burkina Faso. *Nutrient Cycling in Agroecosystems*, 101: 295-315. Doi: 10.1007/s10705-015-9679-4

From farm scale synergies to village scale trade-offs: Cereal crop residues use in an agro-pastoral system of the Sudanian zone of Burkina Faso. *Agricultural Systems*, 134: 84-96. Doi: 10.1016/j.agry.2014.08.012

Multi-scale trade-off analysis of cereal residue use for livestock feeding vs. soil mulching in the Mid-Zambezi Valley, Zimbabwe. *Agricultural Systems*, 134: 97-106. Doi: 10.1016/j.agry.2014.03.002

Maize crop residue uses and trade-offs on smallholder crop-livestock farms in Zimbabwe: Economic implications of intensification. *Agriculture, Ecosystems and Environment*, 214: 31-45. Doi: 10.1016/j.agee.2015.08.012

SOCIAL RELATIONS BETWEEN FARMERS

Cultural diversity has shaped sorghum biological diversity

Vanesse Labeyrie, Montpellier, France, Amélioration génétique et adaptation des plantes (AGAP)

Researchers from CIRAD and their partners from the Kenya Agricultural and Livestock Research Organization (KALRO) have discovered that the social relations between farmers play a central role in the dynamics of the diversity of sorghum grown on the slopes of Mount Kenya. By influencing seed exchanges, social structure shapes local agro-biodiversity. In this region, where there are three ethnic groups, the researchers used network analysis to show how seed circulates: it is exchanged via the social relations between women, who are generally in charge of work in the field. It turns out that women farmers prefer to share their seed with people who live in the same place as them, and subsequently, outside that inner circle, with other members of their ethnolinguistic group. The system of relationships and marriages therefore strongly influence local seed exchange networks and consequently the varieties grown. This work has major implications in terms of the agricultural genetic resource conservation.

PARTNERS. Institut national de la recherche agronomique (INRA, France); Fondation pour la recherche sur la biodiversité (FRB, France); Kenya Agricultural and Livestock Research Organization (KALRO, Kenya)

Seed exchange networks, ethnicity, and sorghum diversity. *Proceedings of the National Academy of Sciences of the United States of America*, 113: 98-103. Doi: 10.1073/pnas.1513238112

Phenotypical measurements on sorghum in an experimental plot. Eastern slope of Mount Kenya
© V. Labeyrie/CIRAD

Indicators
2015 >

INDICATORS 2015

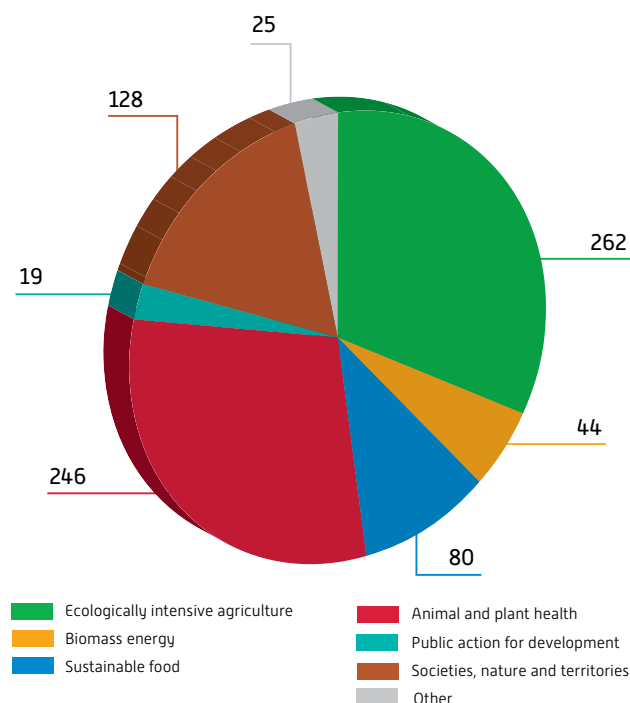
The changes in the main indicators that reflect CIRAD's activities are analysed here. While remaining consistent with the monitoring mechanism for the *2014-2018 CIRAD Contractual Objectives* and CIRAD's main ambitions, expressed in its *2012-2022 Strategic Vision I*, the analysis retains the same structure and indicators as in previous years.

> AN AMBITION OF SHARING SCIENCE TO MEET THE CHALLENGES FACING SOUTHERN COUNTRIES

The establishment's priorities, expressed via the six strategic lines of research set out in the 2014-2019 Scientific and partnership strategy objectives² (SPSOs) are largely reflected in its scientific output in terms of publications. Most of CIRAD's publications are referenced as per those lines of research lines, as shown in the figure below.

The distribution of articles in peer-reviewed journals between the various strategic lines of research – just one line per article – varies very little from one year to the next. In 2015 as in 2014, three lines were predominant: *Ecologically intensive agriculture* (33% of the annual volume of articles), *Animal and plant health* (31%) and *Societies, nature and territories* (16%).

Distribution by line of research of peer-reviewed articles, with or without impact factor



Source Agritrop. DIST-DGDRS.
The 2015 data are partial: they reflect the state of the Agritrop database as of 29 February 2016.

Once again this year, CIRAD has proved its determination to build balanced, sustainable partnerships with scientific partners in the South. Co-publications with at least one author from the South made up the majority (51%) of all publications and the increase in such co-publications since 2011 is continuing.

Co-publications with operators in southern countries*

* A country is classified as a southern country if it is on the OECD/DAC list of official development assistance recipient countries

Peer-reviewed journal articles, with or without impact factor					
Data smoothed over three years	2011	2012	2013	2014	2015*
Articles published with at least one southern author	362	388	419	424	423
Total number of peer-reviewed articles	752	789	832	829	824

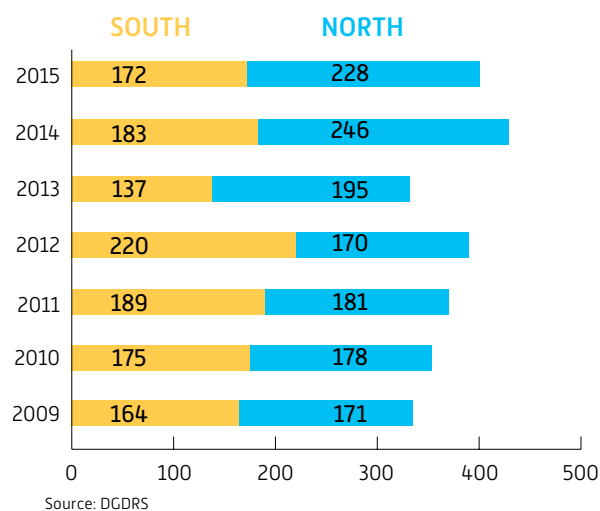
Source Agritrop. DIST-DGDRS.

The 2015 data are partial: they reflect the state of the Agritrop database as of 29 February 2016.

* 2015: provisional data

The number of PhD students supervised by CIRAD has progressed steadily over a long period, although it fell slightly in 2015 compared to 2014.

Supervision of PhD students by CIRAD researchers



Source: DGDRS

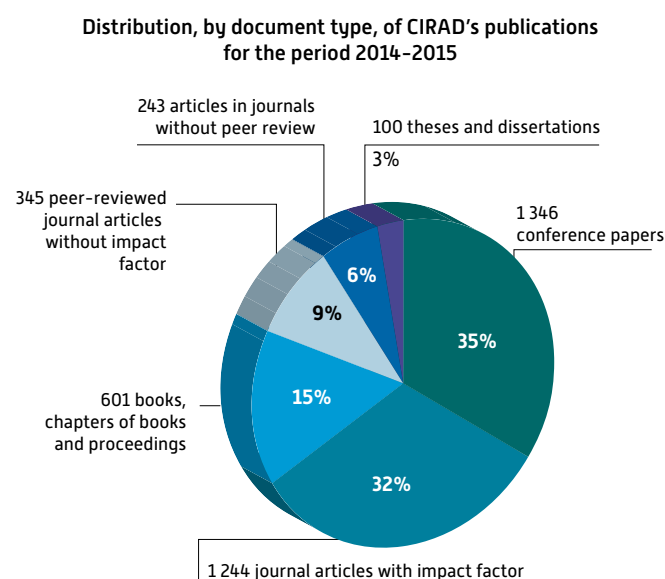
1. Ambition 1. Serve as a global reference for our scientific priorities. Ambition 2. Co-construct strategic AR4D partnerships. Ambition 3. Establish the conditions for effective innovation. Ambition 4. Evolve in order to fulfil our ambitions.

2. Approved by the Board of Trustees on 26 June 2014.

> DIVERSIFIED, HIGH-QUALITY SCIENTIFIC OUTPUT

The efforts made by CIRAD to improve the quality of its scientific publications, ensure scientific recognition of its teams and broaden the range of its outputs so as to reach different audiences are reflected in the results below. CIRAD is continuing to work to ensure global scientific recognition of research for development anchored in the field and co-conducted with its partners in the South, which lies at the heart of its mandate.

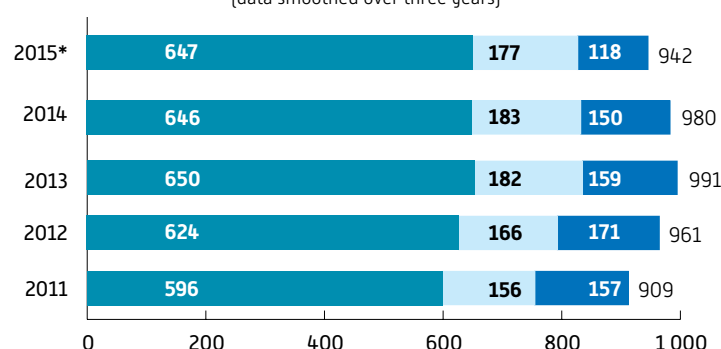
Over the period 2014-2015, articles published in impact factor journals (1244 or 32%) and conference papers (1346 or 35%) accounted for the majority of publications, with an increase in the overall number of publications.



Source Agritrop, DIST- DGDRS. The 2015 data are partial: they reflect the state of the Agritrop database as of 29 February.

The annual number of peer-reviewed journal articles, with or without impact factor, is stable. However, in relation to the total annual number of articles, the proportion of articles in impact factor journals is continuing to increase, as shown below.

Change in the number of journal articles between 2011 and 2015
(data smoothed over three years)



* Provisional data

Journal articles with impact factor
Peer-reviewed journal articles without impact factor
Articles in journals without peer review

After a slight fall in 2014 following a period of considerable growth, the number of Directors of Research is once again on the up.

Research training for CIRAD's senior scientific staff
Number of research directors at CIRAD

2009	2010	2011	2012	2013	2014	2015
107	129	136	143	166	162	170

Source: SIRH, DGDRD

The total number of applications for patents, etc has been stable since 2010. The small number of patents and the fall in the number in recent years are due on the one hand to the high cost of applications and maintenance and the difficulty of defending them in the event of counterfeiting and on the other hand to the fact that CIRAD is increasingly opting to promote its outputs via secret knowledge transfers.

Outreach: patents, proprietary variety protection certificates and software programs

Number of applications for patents, proprietary variety protection certificates and software programs
(in brackets: number of patents attributed)

2009	2010	2011	2012	2013	2014	2015
26 [4]	10 [5]	8 [2]	8 [3]	9 [0]	8 [3]	9 [1]

Source: DelValo, DGDRS

> AGRICULTURAL RESEARCH OPEN TO EUROPE AND THE REST OF THE WORLD

In line with its previous commitments, CIRAD is continuing its agricultural research in partnership activities:

- on a French regional level, notably through site policies; on a national level, through its collaboration with INRA on scientific and international cooperation issues, as well as with other French research and training organisations for environmental and agricultural issues within the framework of the AllEnv alliance and the Agreenium national consortium;
- on a European level with key initiatives (IntensAfrica) to structure research and development operators;
- and on an international level, with a special focus on the 23 platforms in partnership for research and training (dPs) and the consolidation of initiatives undertaken with the Consultative Group on International Agricultural Research (CGIAR).

Platforms in partnership for research and training (dPs)

Region	National platforms in partnership (dPs)	Regional platforms in partnership (dPs)
AFRICA		
	PPZS - Senegal - Lines 1, 5, 6	ASAP - West Africa - Lines 1, 4, 6
	RP-PCP - Zimbabwe - Lines 1, 4, 6	DPFAC - Central Africa - Lines 1, 6
	CRDPI - Congo - Lines 1, 6	SISTO - West Africa - Lines 3, 5, 6
	Forêt Biodiversité - Madagascar - Lines 2, 5, 6	DIVECOSYS - West Africa - Line 1
	PCP Agroforesterie - Cameroon - Lines 1, 5, 6	ONE HEALTH OI - Indian Ocean - Line 4
	PP & G - South Africa - Lines 5, 6	IAVAO - West Africa - Line 1
	SPAD - Madagascar - Lines 1, 6	
ASIA		
	HRPP - Thailand - Lines 1, 6	CANSEA - Southeast Asia - Lines 1, 6
	MALICA - Vietnam - Lines 3, 5	GREASE - Southeast Asia - Line 4
LATIN AMERICA		
	PCPAFS-PC - Costa Rica - Lines 1, 5, 6	AMAZONIA - Amazon Basin - Line 6
	CIBA - Brazil - Line 1	PP -AL - Latin America (10 countries) - Lines 5, 6
		RéSA-CaribVET - Guadeloupe-Caribbean - Line 4
MEDITERRANEAN		
		SIRMA - Maghreb - Lines 1, 5, 6

Source: Platforms in Partnership Office, DGD-RS

More than half (58%) of peer-reviewed journal articles, with or without impact factor, are co-published with an international institution outside the European Union (EU), primarily with institutions in southern countries (51%), as mentioned above. The number of co-publications with institutions in France (47%) is also significant. The increase in the number of co-publications with INRA since 2011 gathered speed in 2015 (see the chart for *Change in number of CIRAD co-publications between 2011 and 2015*, following page).

Geographical mobility of CIRAD staff members was up in 2015 in line with the priority given to placing CIRAD researchers abroad and in the French overseas regions. After a significant increase in dPs between 2012 and 2013, the number of senior scientific staff members posted to platforms in partnership (dPs) and to the French overseas regions is continuing to progress. Of the 23 dPs, 13 are located in Africa and the Indian Ocean, five in Latin America, four in Asia, and one in the Mediterranean. The total number of overseas missions fell again in 2015, particularly in sub-Saharan Africa, which nevertheless remains the

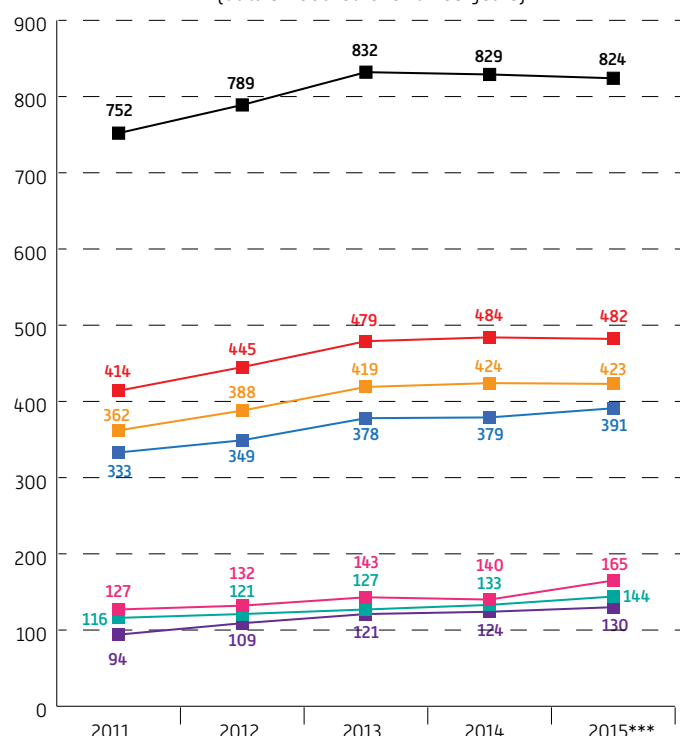
principal destination and has seen a significant increase – greater than the fall in the number of missions – in the number of long-term postings (see charts for *Distribution of overseas postings, according to destination* and *Distribution of missions according to destination*, following page).

Number of senior scientific staff members posted overseas and distribution within platforms in partnership (dPs) and the French overseas regions (in full-time equivalent)

	2013	2014	2015
Abroad	298	297	313
In dPs	130	127	131
In French overseas regions	108	110	116

Source: SIRH, DGD-RD

Change in number of CIRAD co-publications between 2011 and 2015 (data smoothed over three years)



Source Agritrop. Dist- DGDRS The 2015 data are partial: they reflect the state of the Agritrop database as of 29 February 2016

- Articles published with an international institution, excluding EU*
- Articles published with a southern institution
- Articles published with a French institution
- Articles published with an EU institution, excluding France
- Articles published with INRA
- Articles published with a northern institution, excluding EU
- Total number of peer-reviewed journal articles, with or without impact factor**

[*]An international institution is an institution not located in France. It may be in a southern or northern country.

[**]The co-publications are calculated by citation count. This count measures the "participation" of the institution in scientific output: the institution is credited with unitary participation in a publication when its presence in the publication is confirmed by its address. Consequently, the values obtained for French, EU or international operators are not additive.

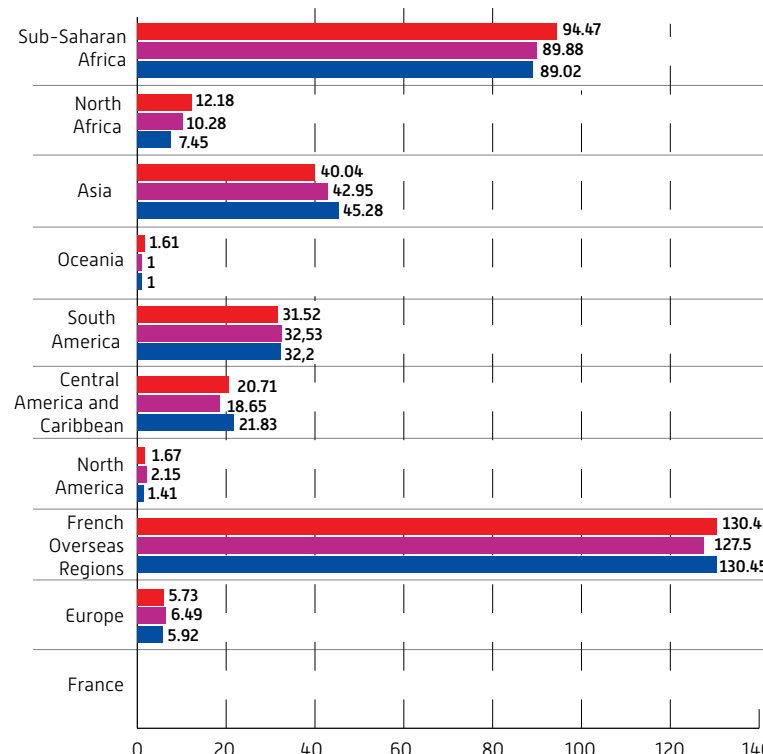
In 2015, CIRAD increased its success rate for FP calls for proposals, from 13% in 2014 to 20% in 2015, as shown below, whereas the average success rate in Europe is 12% and priority is still given to issues centring on Europe. These results may reflect greater familiarity with the operating methods and demands of the recent Horizon 2020 programme.

CIRAD's EU research and development projects (FP) between 2011 and 2015

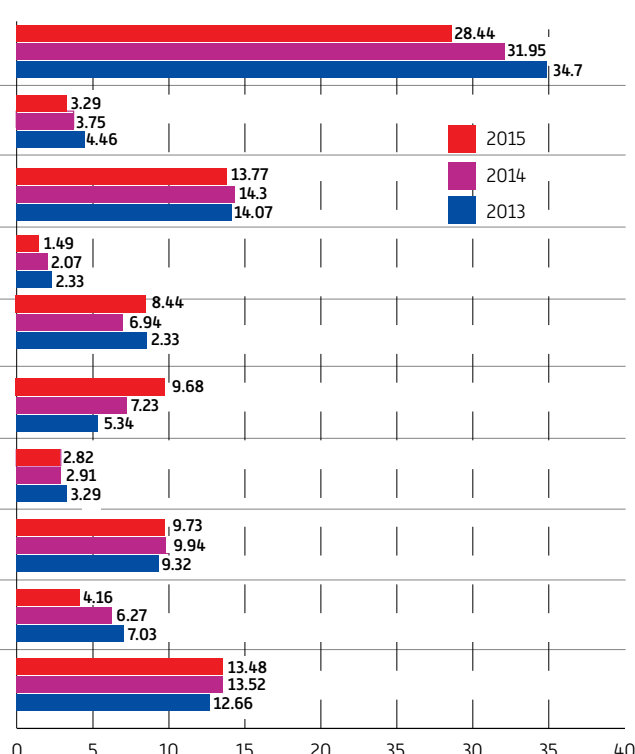
	2011	2012	2013	2014	2015
Number of projects submitted	21	20	24	24	30
Number of projects funded	5	8	7	3	6
Success rate [%]	24	40	29	13	20
Number of projects coordinated by CIRAD	3	0	3	0	1

Source: Europe Office, DGDRS

Distribution of overseas postings, according to destination (in full-time equivalent)



Distribution of assignments, according to destination (in full-time equivalent)

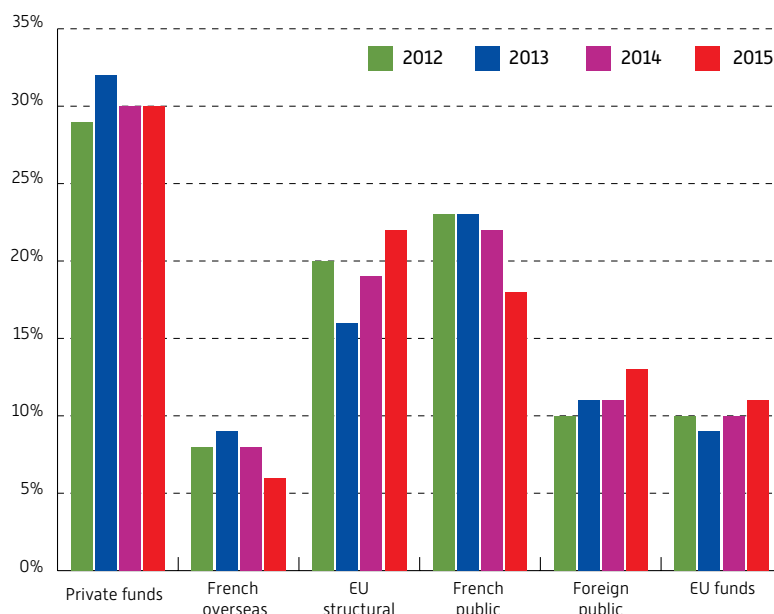


> A STRUCTURE AND RESOURCES ADJUSTED TO MEET NEW CHALLENGES

The work begun by the organization within the framework of its Resource Development Pact with a view to consolidate its economic model and the efforts made by its staff to optimize its portfolio of contractual resources are reflected in the overall increase in contractual activity, as shown in the chart for Resources generated by CIRAD: amount and annual breakdown as a percentage (excluding joint contracts). The results for 2015 confirm the greater profitability of contractual activity and the increase in European funding (structural funds and R&D funds). Moreover, operating costs were stable in 2015 despite an increase in the payroll and in costs resulting from staff mobility.

CIRAD has embarked upon a dynamic employment policy, with a view to building the skills required by its scientific and geographical partnership strategy. While there was again a slight drop in staff numbers in 2015, the sharp fall seen over the previous four years is now at an end.

Resources generated by CIRAD: amount and annual breakdown as a percentage (excluding joint contracts)



Total number of CIRAD staff members (full-time equivalent)

	2010	2011	2012	2013	2014	2015
Number of "classified paid" permanent contracts	1752	1739	1717	1681	1635	1627
Number of grant-funded PhD studentss	83	81	72.6	73.6	64	58

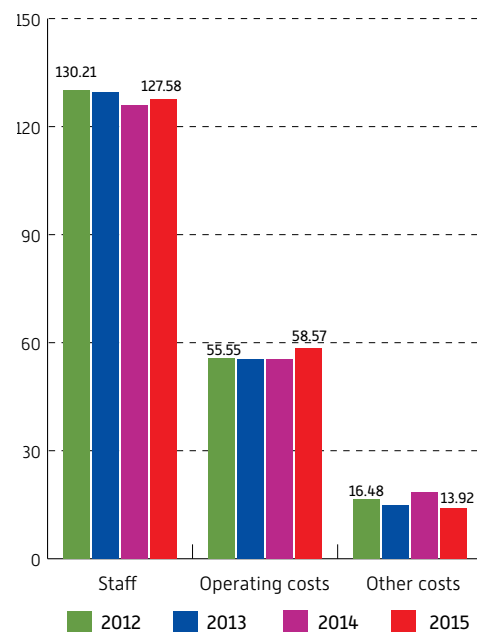
Source: SIRH- DGDRD

Annual breakdown of "classified paid" jobs per category (including grant-funded research students with CIRAD contracts) (as a percentage)

	2010	2011	2012	2013	2014	2015
Senior staff	59.6	60.6	62	62.9	64.1	65.9
Grant-funded PhD students	4.6	4.5	4.1	4.2	3.8	3.43
White-collar staff	31.5	31.6	31.5	31	30.6	29.39
Ancillary staff	4.4	3.4	2.4	1.8	1.5	1.27

Source: SIRH-DGD-RD

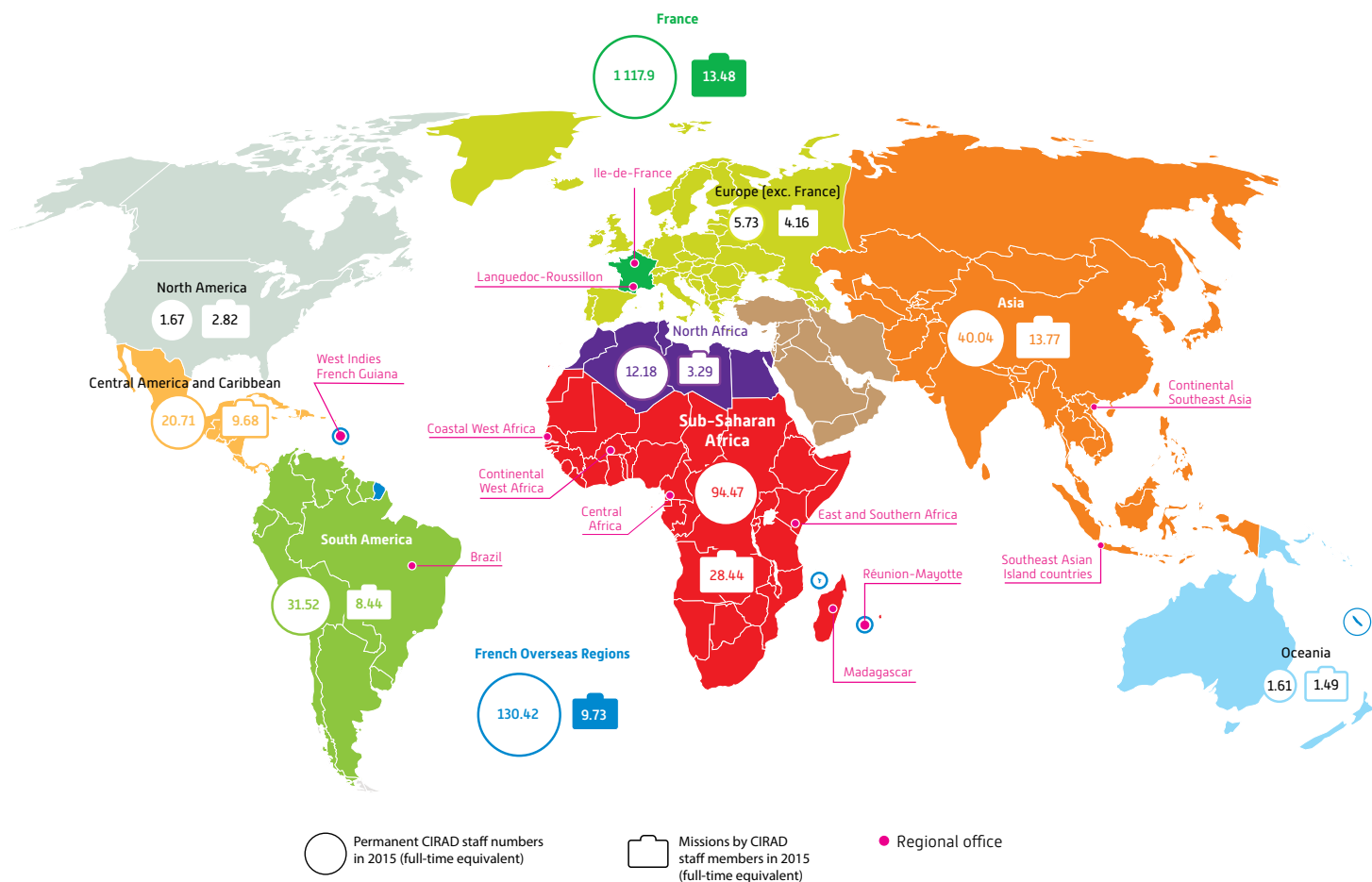
Operating costs, excluding internal subcontracting 2010-2014, in million euros



Source for both charts: DCAF, DGDRD (see "Management report")

ANNEXES

CIRAD worldwide (Data 2015)



Organization in June 2016

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